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BIOLOGICAL AND MEDICAL RESEARCH AT THE BUREAU OF SCIENCE, MANILA

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HISTORY

WHEN Americans occupied the Philippine Islands, laboratory facilities in the field of medicine were practically non-existent. Such as had existed in Spanish times, chiefly for chemical analyses, were reorganized into a "Municipal Laboratory of Manila" in charge of W. J. Calvert, who returned to the United States in 1901.

The genesis of the Bureau of Science should rightfully be placed in the organization by the United States Army in 1899 of the (first) Board for the Investigation of Tropical Diseases in the Philippine Islands. Richard P. Strong was appointed president of this Board by the Secretary of War. Strong proceeded at once to organize an Army Pathological Laboratory which, from 1899 until the Government Laboratories were established in 1901, did practically all of the medical diagnostic work for hospitals and physicians in and about Manila. Strong was well equipped for this work and did much to establish medical diagnosis on a rational basis. Prior to his work the situation was chaotic.

When Drs. Simon Flexner, L. F. Barker, Joseph M. Flint, and Frederick P. Gay, of the Johns Hopkins Commission for the Study of Tropical Pathology arrived in Manila, in the summer of 1899, they were invited to work in this laboratory. The invitation was accepted during their stay of two months in the Islands. Barker and Flint studied such clinical problems as the differential diagnosis of malaria and typhoid fever, working especially in the wards, among American soldiers. They also studied beriberi, going to Cavite to work among prisoners.

Flexner and Gay studied intestinal infections, especially bacillary dysentery. It was at this time that Flexner isolated the *Bacillus dysenteriae*. He found it in

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three fatal cases of dysentery and also in some non-fatal cases, by rectal cultures. This was the first confirmation of Shiga's discovery. Along with other strains of *Bacillus dysenteriae*, Strong isolated a strain which Lentz subsequently placed in a separate group, because of its fermentation and its serum reactions. Probably the first serum ever manufactured and used in the treatment of bacillary dysentery was made and used in this laboratory. *Micrococcus melitensis* was also first isolated in Manila in this laboratory and redescribed from a fatal case of undulant fever. The pathological histology and the rôle of *Balantidium coli* infection was also first demonstrated there, and an extensive study of the etiology of the dysenteries in Manila was prosecuted by Strong and Musgrave.

The Government Laboratories of the Philippine Civil Commission were established at 781 Calle Iris in October 1901. Dr. Paul C. Freer was appointed superintendent and in his first report we note that from the very outset the routine work of these general laboratories included diagnostic analyses of specimens from hospitals, from the board of health, and from municipal physicians, with bacteriological examinations, dissection of plague-suspected rats and other similar procedures. A serum institute was a part of the original organization. Doctor Freer in his first report stressed the need and the value of medical research in the Philippines. Strong was appointed first director of the biological laboratory, returning from leave to this position on January 1, 1902. The work of the Army Pathological Laboratory was largely transferred to the Government Laboratories.

In October 1902 the present buildings on Calle Herran were begun and they were occupied in September 1904. In 1902 Miss Mary Polk was appointed librarian, and the Bureau of Science library began its amazing growth which has continued until the present time, when it is recognized to be the best scientific library in the Orient, east of Suez. On December 31, 1932, there were in the library 76,498 bound volumes, 60,610 unbound volumes, and 2,622 current periodicals.

As early as 1904 Doctor Freer stated that the Government Laboratories welcomed scientific investigators from other countries and this policy of international coöperation has been continued.

Tropical medicine was an important part of the Laboratory's problems. Quoting from Doctor Freer's third annual report,

> interest in tropical medicine has developed markedly of recent years, and it must be understood that not only has this branch of scientific work taught us to understand the Tropics to as great an extent as has any other field, but it has reacted beneficially upon medical knowledge in temperate climates, and much has been learned from the facts gained near the equator which has been of advantage in the practice of medicine at home.

Strong, during his thirteen years in the Islands, had much to do with the development of the biological laboratories.

On November 1, 1905, the title of Government Laboratories was changed to "The Bureau of Science," a name soon made famous throughout the world because of the high quality of its studies in many fields of tropical science. Not the least important phase of its activities was and has always been medical. For example, there are the interesting facts that the Director of the Bureau of Science was made Dean of the Philippine Medical School in December 1906 and that six members of the staff of the Bureau were actively teaching in the School after its opening in June 1907, with fifty-four pupils. The laboratory studies of the students were done almost entirely in the

Bureau. In fact, quoting Director-Dean Freer, relations between the bureau and the school were "so inseparable that one can scarcely be considered without the other."

In 1908 the Bureau of Science had a large part in the formation, at the meetings of the Philippine Islands Medical Association, of the Far Eastern Association of Tropical Medicine, and the proceedings of the first meetings of the new organization, held in Manila in 1910, were published in the *Philippine Journal of Science*. The *Journal* had appeared under the auspices of the Bureau of Science in January 1906 and has been published consecutively ever since, building for itself a name known throughout the world for the excellence of its articles. Much of the material appearing in the pages of this journal has been submitted by members of the staff of the Bureau. That this staff was making an unusual reputation for itself in the field of medical research may be gathered from the statement of that great German parasitologist, Professor Fülleborn of the Hamburg School of Tropical Medicine. He stated that the Bureau of Science laboratories furnished better opportunity for the study of tropical medicine than any other institution with which he was familiar.

One of the main reasons why the opportunities have been so great has been the fact that all phases of research in tropical science have been housed in one group of buildings under one director. The utmost in coördination has been possible. No one can deny the close interrelationship of medical research and other branches of tropical science, especially in such divisions as chemistry, entomology, anthropology, and botany, and not excluding ornithology and fisheries. The whole field of tropical science is bound together, and no one can separate it rigidly into independent divisions. In this respect what a unique institution the Bureau of Science has been! Biologists and chemists working side by side; ornithologists, entomologists, ichthyologists, and anthropologists together under the coördinating influence of a single bureau, directed by men of broad scientific vision.

The Bureau of Science has never shirked routine work. No less than four and a quarter million routine examinations in the field of medicine and health alone have been made by the Divisions of Chemistry and Biology since 1905; and no fewer than 223 million units or ampules of vaccines and serums have been manufactured by the Bureau of Science in the same time. It is beyond the power of the human mind to visualize what this has meant in the life of the Philippine Islands. Hundreds of thousands of Filipinos have been spared the horrors of death by smallpox; millions have been protected from cholera, typhoid fever, and tetanus. The more than 622,000 bottles of tikitiki sold or given away have prevented beriberi in many thousands of Filipino children, and thousands have been saved from death by antirabies treatment.

The Bureau of Science safeguards public health in the Philippines to an extent far greater than is generally known. For example, quite apart from fundamental researches into the nature and control of local diseases, and in addition to basic analyses of such staple foodstuffs as rice and soy beans in relation to their vitamin content and nutritive values, the Bureau of Science examines routinely all sorts of foods submitted by various agencies such as the Bureaus of Health and Customs. These tests, to determine whether or not the provisions of the Food and Drugs Act are satisfied, include such foodstuffs as imported canned salmon, sardines, etc., local ice cream, coconut and other vegetable oils, meats, lard, milk, soft drinks, alcoholic beverages, bread, confectionery, fruits, vegetables, fish, sugar, molasses, cheese, flour, and cereals. Soaps, dyes, drugs, and medicines are also tested to screen out those injurious to health and those which are mislabeled. Manila's food handlers are examined, as well as samples of water from all over the Archipelago. The strength of cement and other structural materials is measured from the standpoint of public safety.

A tremendous number of biological specimens are examined. Practical training is given yearly to thousands of Filipina housewives in the preparation of food. Demonstrations are made not only daily at the Bureau of Science but by traveling demonstrators in provincial towns.

Finally, the Bureau of Science conducts a consultation service which includes all phases of life in the Islands. Any citizen at any time may go to the Bureau for scientific information about any subject.

But it must not be forgotten that all this routine work in medicine rests on the firm foundation of medical research. Without investigation, the routine work could not exist. For example, it was only following intensive research that tikitiki was developed as a cure for infant beriberi. The experience at the Bureau has demonstrated that in a well coördinated scientific institution routine examination and scientific research can go on together, each benefiting by the other. In biological problems affecting human health, routine and investigative work are always closely associated.

We wish to pay tribute, in this consideration of the Bureau of Science, to Dean C. Worcester, who, as Secretary of the Interior of the Government of the Philippine Islands, drafted legislation which had for its object the placing of scientific work upon a firm and lasting foundation. To Mr. Worcester more than to any other individual belongs the credit for the establishment of the Bureau of Government Laboratories which became the Bureau of Science. It was Worcester who had the vision, it was Worcester who had the energy to make real his dream. We wish also to pay our respects to Paul C. Freer, the first director, a thorough gentleman and a polyglot, a man of great scientific and business ability, through whose foresight, judgment, and perserverance, the Bureau was so successfully carried through its early years. Doctor Freer was not only an able chemist and administrator, but a capable, independent investigator whose observations on the effects of tropical sunlight were noteworthy. His successors have carried on in the same spirit of unselfish devotion to science, and although none has been primarily interested in medical science, yet each has lent his unstinted support to medical and biological research.

Numerous quotations could be given to indicate the esteem in which the Bureau was held locally and abroad. For example, the *Britannica Year Book* in 1913 described the Bureau of Science as "a great research institution that is now classed with the best in the world." Members of the staff of the Bureau were and are participating in scientific congresses all over the world. Many of those who have returned to the United States are occupying positions of prominence.

Former Governor General Cameron Forbes in 1928 wrote that the Bureau of Science

> was probably the most important single institution in the Philippines, and for years it rendered vitally important service not only to the Philippine Government in its various departments but also to the world at large, through its scientific research work. It attained a position of great eminence and credit, but on account of the lack of adequate support and adequate personnel it does not occupy the position

today that it did from 1905 to 1915. Reorganization and the appointment of personnel adequate in all respects is imperative. The work of this institution is of inestimable value to the Philippines and to the world at large.

Although this paper is primarily concerned with medical research at the Bureau of Science, it would not be amiss to call further attention to the diversity of the Bureau's contributions to the general welfare of the people of the Philippine Islands.

A quotation from Victor G. Heiser, who was for many years director of the Philippine Health Service and who had a very active part in encouraging and aiding the growth of the Bureau of Science, will make clear how widespread have been the interests of this Bureau.

Referring directly to the Bureau of Science, Heiser wrote:

> The number of uses to which these laboratories were put surprised even the most ardent supporters of the movement. Answers were available as to whether a curious mineral found was gold, whether a resin gathered in the jungle had commercial value, whether a food was adulterated or poisonous, or whether an illness was cholera or plague or leprosy or something harmless. The durability of road-making material could be tested, the possibilities of silk worm culture were worked out, the commercial value of many curious tropical products could be ascertained; in short, definite knowledge was to be had instead of surmises which so often are incorrect. If a photograph were needed, this bureau not only took it but filed it away so that it might be available in the years to come. A great scientific library was assembled, serving as a storehouse of knowledge not only for the Philippine Islands but for much of the East. Entirely new industries sometimes resulted from the researches. Great contributions to the world's knowledge were made. The scientific work was of the highest character. *The Journal of Science*, published by the Bureau, became a recognized source of authority in the principal countries.

In reviewing the history of the Bureau of Science it has not been easy to curb enthusiasm. One might gain the impression from this paper that the Bureau has been a leader in every public health investigation in the Philippines. Therefore it may be well in passing to note that a great deal of important work has been done entirely outside the Bureau. For example, the Philippine Health Service under the notable leadership of Victor G. Heiser, and subsequently, has done outstanding work often independently of the Bureau of Science. Unfortunately the scope of this article is limited to the latter Bureau.

COÖPERATION

Coöperation has been the keynote in all the activities of the Bureau, particularly in medical research. For example, as early as 1915 the Director of Health began to send health officers to the Bureau for definite periods to obtain laboratory and practical instruction, a policy which was continued for several years. The International Health Division of The Rockefeller Foundation has been associated with the Bureau, first in 1921 and almost continuously since that time. So, too, the Japanese Army and Navy for the past ten years have been assigning medical officers to study at the Bureau. Other organizations in other countries have sent research workers from time to time, and to all the Bureau has extended a generous welcome. Many notable papers have resulted from these associations, as will be seen by consulting the bibliography. The association between the Bureau and the United States Army Medical Department has been very productive.

UNITED STATES ARMY MEDICAL DEPARTMENT RESEARCH BOARD

The United States Army Board for the Study of Tropical Diseases as They Exist in the Philippine Islands was reëstablished in 1922 as The United States Army Medical Department Research Board, located at the Bureau of Science. As noted by Simmons, who was president of the Board during the years 1928–30, this arrangement was advantageous, because the work at the Board was greatly facilitated through the close contact of its members with the personnel and the scientific resources of the Bureau.

Some of the work of this Board is not within the scope of this paper, since it was done elsewhere than at the Bureau of Science. The history of the Board has been ably written by Vedder, and his bulletin should be consulted for detailed information. However, even when the Board was not housed at the Bureau, it maintained cordial relations with the Bureau, and the Bureau conferred on the Board the privilege of using instruments, apparatus, and library. Vedder (p. 25) states that without the excellent library of the Bureau "it would be impossible to study the literature of any disease or problem, and it is difficult to realize how helpless the research worker is without adequate library facilities."

One cannot but feel pride in the work of this Army Board when one recalls Vedder's work, which demonstrated the amebacidal action of emetin *in vitro*; the work of Phelan and Kilbourne and of Chamberlain and Vedder in regard to fundamental factors in the cause, cure, and prevention of beriberi; Craig's extensive studies in malaria; the notable studies of Ashburn and Craig, Siler, Hall, and Hitchens, and of Simmons, St. John, Reynolds and Holt in dengue; of Holt in malaria and of Holt and Kintner in equine osteomalacia; and the long series of investigations by Phalen, by Chamberlain, and by Fleming on the subject of tropical climate and light as they affect human life in the Tropics. It has indeed been a notable chapter in the history of medical research. The part played by the Bureau of Science in its affiliations with the Army Board has been acknowledge by all as of outstanding importance.

While there has been no such direct cooperation between the United States Navy and the Bureau of Science yet the Bureau has on many occasions afforded special opportunities to members of the medical personnel of the Navy. Stitt, for example, when assigned to Cañacao Naval Station, made use of the special facilities of the Bureau. No doubt the Bureau may justly claim a part in Stitt's preparations for the publication of his notable and practical text books in clinical and laboratory tropical medicine. Garrison of the Navy served a two-year detail with the Bureau and published several papers dealing with parasitic infections.

RESEARCH

In the following pages I have attempted to review some of the notable products of medical research in the laboratories of the Philippine Bureau of Science. It is not possible to do justice to the many papers which have been published as a result of studies in the Bureau, but my hope is that this brief review will give some insight into the magnificent achievements of the Bureau of Science in the field of medical research. I have perforce had to omit references to veterinary science and to skim all too hurriedly over many phases of the medical studies. While the bibliography has been carefully prepared, I am afraid that important omissions may be noted. It should be remembered that at all times medical research has been only one phase of the scientific program of the Bureau, which has included chemistry, botany, mining, fisheries, ornithology, entomology, anthropology, and the publication of the *Philippine Journal of Science*. Although research in medical and allied sciences has been only one phase of the program it has not been the least.

ASIATIC CHOLERA

It is not easy to visualize the devastation caused by the outbreak of cholera in the Philippines beginning in March 1902. But with nearly 4,000 deaths in two years' time in Manila and over 90,000 deaths in the provinces, one can understand why this terrible malady at once engaged the attention of medical research workers in the Government Laboratories. Strong, first director of the biological laboratory, at once began to study this disease. As a result of his investigations it was shown that cholera was being disseminated chiefly through foodstuffs, not through water supplies as in the classical Hamburg epidemic. Flies and water were only occasional sources of infection.

Strong also began intensive studies in an attempt to obtain practicable and efficacious protective inoculation against the disease. Haffkine's method had been tried but because of severe local and general reaction to the injection it was impossible to secure the coöperation of the people. It is noteworthy that Strong had begun his work in Berlin in the laboratories of Professor Wassermann in Koch's Institut für Infektionskrankheiten. Through Strong, that great German institute had a formative influence in the early days of the Bureau, setting the highest standards in medical research.

Others at the laboratory collaborated with Strong in his cholera studies. Wherry, for example, studied the biology of the cholera spirillum, particularly with reference to variations which may occur in a culture of the organism. Marshall showed that there is a great difference between individual strains of cholera, and that this variation is deep-seated.

Nichols, of the United States Army Medical Corps, and Andrews, of the Bureau of Science, reported extensive investigations into the treatment of cholera during the 1908 epidemic in Manila, and confirmed, in a most useful way, the fact that intravenous injection of saline solution reduces by 80 per cent the mortality from collapse. They also remarked that nearly one-third of those who survived the state of collapse died later of uraemia, a condition for which there was no satisfactory treatment.

Ohno studied the behavior of cholera vibrios in culture media of different degrees of acidity and alkalinity. He found that different strains of cholera vibrios react differently toward acid and alkaline solutions, and that the medium in which the morphology appears most typical is different for different strains. He showed further that the more acidity or alkalinity of media is increased the more the agglutinability of the organism is decreased.

Sellards made a most significant contribution to the study of cholera when he found that cholera patients show a definite tolerance to alkalies, a considerable excess of sodium bicarbonate being required to render their urine alkaline, as compared with normal individuals. He demonstrated that the early administration of alkalies practically eliminated death from uraemia. This was an original finding of greatest importance, a definite contribution by the Bureau of Science to the treatment of cholera throughout the world.

Aron studied the chemistry of blood in cholera and found that in the collapse stage loss of water in the blood is regularly encountered, accompanied by a corresponding loss of chlorides. Later, the blood again acquires its normal content of water but the salts are not replaced, so that the blood is hypotonic.

McLaughlin, of the Health Service, and

Whitmore, of the Bureau, collaborated in a study of cholera and cholera-like vibrios found in the Philippines. Their work confirmed the belief that hogs do not act as cholera carriers. They also strengthened the observation that non-cholera vibrios will not agglutinate in specific anticholera serum in dilutions weaker than 1 to 10. They failed to find any haemolytic agglutinating strains of the "*El Tor*" type and they were unable to make cholera-like vibrios acquire agglutinability with cholera sera. McLaughlin at the Bureau of Science, while acting director of Health, was one of the first to demonstrate cholera carriers in the Philippines.

Crowell, on the basis of ninety-two autopsies on cases of cholera, outlined the anatomical features upon which a diagnosis can be made. Schöbl, in a study of the viability of cholera vibrios in Manila waters, found that vibrios disappeared first from distilled water and last from sea water, at room temperatures. They remained alive in tap water up to fifty-six days, and Schöbl therefore corroborated experimentally the theoretical possibility in the Philippine Islands of introducing Asiatic cholera from port to port by means of water carried on board ships. These studies also demonstrated that water polluted with human excreta may remain a source of cholera infection for considerable periods.

Schöbl also found experimentally that the inoculation of relatively few cholera vibrios into the gall bladder may produce carriers in animals and that the amount of inoculum appears not to have any direct bearing on the duration of the carrier state. Moreover, he showed that an increased flow of bile does not hasten the disappearance of cholera vibrios from either the gall passages or the intestine; in fact, the administration of cholagogs tends to prolong rather than to shorten the duration of the carrier state.

Schöbl further showed that distribution of cholera vibrios in the alimentary canal of experimental cholera carriers fed on ox bile was more extensive, elimination of cholera vibrios in faeces was more constant, and cholera vibrios were present in the alimentary canal in larger numbers than in the case of the carriers that received no bile.

In collaboration with Pañganiban, Schöbl attempted preventive vaccination and vaccine therapy in guinea-pig cholera-carriers but failed to note any shortening in the duration of the carrier state. Specific immune bodies were shown to be present in the blood serum of experimental cholera carriers. Schöbl also made a useful survey of chemicals which might be used in the drug treatment of cholera carriers. These studies prepared the way for further investigations and indicated that such carriers by no means present a hopeless problem.

Crowell and Johnston, as a result of the examination of the intestinal contents and bile of 269 cases of cholera and of cholera carriers, made plain the importance of routine examinations of the bile as well as the faeces in suspected cases, because in some cases vibrios were found only in the bile.

Pañganiban and Schöbl experimented to find a method for the preservation of cholera stool specimens for delayed bacteriologic examination. They found that sodium chloride solution or ox bile gave good results. Schöbl and Andaya confirmed the observations made in other countries that immune bodies are found in the blood of persons vaccinated with cholera vaccine. They found antibodies persisting for from six to ten months and also showed that the degree and duration of immunity are directly dependent on the amount of vaccine injected, but still more so on the number of injections given. They advised that wholesale vaccination in areas where outbreaks occur every year should be completed at least one month before the time when an epidemic might be expected, a point of considerable practical importance.

Schöbl and Ramirez, in a survey of artesian wells in Manila and vicinity, found cholera-like vibrios in seven of seventy-two artesian wells examined. They noted that cholera-like vibrios differ from true cholera vibrios in that they are not agglutinable by cholera serum and that when freshly isolated they are more strongly haemolytic than freshly isolated cholera strains. That they are closely related was indicated by their coincidence in cholera faeces and by the fact that cholera-like vibrios always increase in the faeces of a population immediately before an outbreak of cholera. This fact Schöbl and Ramirez showed to be of great significance from a sanitary and epidemiologic viewpoint. In the test for vibrios there is a very sensitive method for detecting faecal pollution of waters, food, vegetables, and various drinks.

PLAGUE

Herzog and Hare investigated the highly important question of whether or not, in an endemic area, plague may lie dormant in a population, ready at any time to flare up in an epidemic. At the time of their studies the question was more than hypothetical, because Manila was an endemic focus of bubonic plague. From their studies it was concluded that latent or dormant plague did not exist in the population of the Philippines.

Herzog published in 1904 a useful article on plague, which was based on twenty autopsies on patients succumbing to this disease. This publication reviewed the question of plague diagnosis, offered an excellent guide for the performance of a systematic plague necropsy, and presented the author's investigations into the mode of dissemination of plague, at that time an undetermined problem. Herzog, in another paper, pointed out the frequent occurrence of renal hyaline-fibrin thrombosis in bubonic plague, a histopathologic change which he was first to described and to interpret.

Strong, in 1906, reviewed the question of prophylactic injections for plague, calling attention to the fact that, although various reports had been published of experiments with protective inoculations of killed organisms or their extracts, no successful experiments had ever been carried out with human vaccination, that is, with injections not of killed organisms but of living attenuated pest bacilli. Strong was the first to experiment with such plague vaccinations, and he showed that such injections could be made with safety. Although this method of protecting against plague did not prove to be as successful as was hoped, the experiments, in retrospect, were notable because they required unusual vision and courage.

In 1907 Strong reported further on his very extensive and intensive studies in plague immunity. It must be remembered that when Strong began his experiments the mode of plague transmission was still unproved. Vaccination seemed to offer the chief hope in combating this widespread and dangerous disease.

Seldom in the history of medical research throughout the world have more complete studies of a disease been made than were published in regard to pneumonic plague in 1912 by Strong and his colleagues Teague, Barber, and Crowell. During the winter of 1910–11 there had been, in Manchuria, an extensive outbreak of pneumonic plague which overwhelmed the local medical personnel. There were 50,000 deaths. The Bureau of Science had made itself known as an oasis of scientific medicine in the Far East, so that it was natural for the State Department of the United States to call upon it for aid. The response of the Bureau was immediate, and not only did Strong and Teague from the Bureau of Science aid decisively in controlling the outbreak but they also very materially increased our knowledge of the etiology, bacteriology, pathology, clinical course, and prophylaxis of pneumonic plague. The American Red Cross met part of the expenses of the expedition.

When we recall that one is almost certain to acquire a fatal infection of this disease by merely walking, without proper masks and uniforms, through a ward filled with pneumonic plague patients, we can begin to realize the heroism with which these painstaking and monumental studies were made by the personnel of the Bureau of Science. Working all day, every day, throughout the epidemic, giving intravenous injections, leaning over coughing patients, making physical examinations and autopsies, these men, aided upon their return to laboratories of the Bureau by Barber and Crowell, were able to make the following observations:

1. During an epidemic of pneumonic plague the disease is spread directly from man to man by droplet infection and by more or less intimate contact of healthy individuals with infected persons. In no other disease is the individual so dangerous and in no other disease does danger from droplet infection approach that which exists in pneumonic plague.

2. That there could be a rapid spread of the pneumonic type of plague during a Manchurian winter and never in such a country or climate as in India or the Philippines was explained by Teague and Barber on experimental grounds. They showed that the reason lay in the fact that fine droplets of pneumonic plague sputum disappear very quickly, with a consequent death by drying of the bacilli, except in places where the atmosphere has a very small water deficit. Such an atmosphere is rare in warm climates but common in very cold ones. Frozen pulverized sputum remains infective for long periods of time.

3. Infection in epidemic pneumonic plague results from inhalation, the primary point of infection being some portion of the bronchi, thence progress is made to the lungs where bacilli multiply rapidly to produce first lobular and then general lobar involvement of the lung tissue. Primary plague septicaemia sometimes occurs.

4. The organism of pneumonic plague is the *Bacillus pestis* of bubonic plague. Its virulence is no greater in one type of plague than in the other.

5. Prophylactic inoculation can not be relied upon even as a reasonable means of protection against pneumonic plague. A proper mask furnishes the only reliable method of protection.

Here, then, were classical papers in medical research emanating from the Bureau of Science.

AMOEBIASIS

Musgrave and Clegg in 1904 published an extensive study of amoebiasis. In this work they introduced the name "amebiasis" to cover all grades of infection and their term has since come into general use. They described methods by which amoebae could be secured in pure cultures not only from water, soil, and other substances, but from dysenteric stools and from ulcers in the human bowel. (This method was later shown not to apply to the *Entamoeba histolytica.*) The authors also studied the reactions of amoebae to various physical conditions of light, heat, and moisture, and investigated the etiologic significance of the organisms. An extensive review of the literature was included. Musgrave also discussed thoroughly the prophylaxis and therapy of amoebiasis.

Walker studied the amoebae of Manila and concluded that those in the water supply are non-pathogenic. The pathogenic entamoebas he did not succeed in cultivating by Musgrave and Clegg's technique. Walker stated the important conclusion that a differential diagnosis could be made between *Entamoeba coli* and *Entamoeba histolytica* by microscopical examinations. He further noted the fact that the prophylaxis of amoebic dysentery is identical with that for other intestinal infections such as typhoid fever and cholera. Chamberlain and Vedder, in a series of experiments, demonstrated that ultra-violet rays will kill the amoebae, motile or encysted, in a water supply. Sellards investigated immunity reactions with amoebae and, in a series of experiments, demonstrated no production of immune bodies for amoebae in the sera of amoebic dysentery patients. Walker and Sellards undertook a notable series of experiments to determine experimentally the etiologic relationship of different species of amoeboid organisms to endemic tropical dysentery. It must be remembered that, at the time, the etiologic relationship of the entamoebae to dysentery was a much debated question, with views ranging all the way from an opinion that amoebae were guardians against disease in man to the view that all amoebae are or may become pathogenic.

Walker and Sellards, it should be noted, performed their experiments on human volunteers. The further one delves into the history of medical research at the Bureau of Science the more one is impressed with the courage and intelligence of its scientists. Time and time again, as with plague, beriberi, yaws, dengue, and leprosy, obscure problems were attacked by direct human experimentation. It is doubtful if any other research institution the world over has such a notable record in this respect. Due honor has yet to be given the Bureau of Science for its contribution, along these lines, to medical science. Walker and Sellards used volunteers in Bilibid Prison who were therefore under complete experimental control. This was the first time amoebic dysentery had been studied by experiments upon man.

The conclusions of Walker and Sellards cover three pages of fine print and can be summarized only briefly here. Among other things, Walker and Sellards proved beyond cavil that *Entamoeba histolytica* is the essential etiologic factor in endemic tropical dysentery. The incubation period varied from 20 to 95 days. They showed that the "*Entamoeba tetragena*" of Viereck is identical with *Entamoeba histolytica* of Schaudinn, the "*tetragena*" cysts being developed in the life cycle of *Entamoeba histolytica*. They observed a large percentage of latent infections wholly consistent with and explanatory of clinical and pathological experience. They found the *entamoeba* to be an obligatory parasite, not propagated outside the body of its host, and they pointed out the danger of human carriers of the disease who are constantly passing in their stools the resistant, encysted stage of *Entamoeba histolytica*. These carriers, Walker and Sellards noted, are probably the chief agents in the dissemination of entamoebic dysentery.

Walker and Sellards, by their notable experiments, were able to put the diagnosis and prophylaxis of entamoebic dysentery upon a rational basis. Their work has stood the test of time and has not been surpassed in excellence by any experiments anywhere in the study of the dysenteries. Sellards and Leiva studied experimentally treatment of amoebic dysentery in cats with emetine and with quinine, confirming results of other investigations. In another paper Sellards and Leiva, as the result of some experiments upon cats, concluded that stasis is probably an important factor in determining the location of lesions within the large bowel in spontaneous amoebic dysentery in man.

BACILLARY DYSENTERY

Barber published a study of certain strains of dysentery bacilli in which he utilized his famous method of isolating single cells. In this way his cultures were started with single bacilli and all chance of multiple strain culture was eliminated. Pañganiban and Schöbl modified the methylene blue-eosin-lactose medium and were able to report considerable improvement in diagnostic technic for the detection of *Bacillus dysenteriae*.

Kusama showed that the bacillus of dysentery is fairly resistant to drying. It will survive a considerable length of time in water, longer in sea water than in tap water. Vazquez-Colet demonstrated the existence of healthy carriers of *B. dysenteriae* in the Philippines and thus contributed to our knowledge of the local epidemiology of this disease. Morishima made some careful studies regarding the constancy of types of *Bacillus dysenteriae* and concluded that the classification, grouping, and subgrouping of *B. dysenteriae* are not of such importance as has seemed to be the case. The Shiga-Kruse group appeared to be stable but in the other main group there is considerable variability.

Lacy, and later Schöbl and Villaamil, investigated the serological grouping of *Bacillus dysenteriae*, contributing to a better understanding of the basic factors underlying the practical diagnostic reactions of these dysentery organisms. One important point developed in these studies was that not only cultural but also biological and serological methods should always be employed in attempting a diagnosis of bacillary dysentery.

LEPROSY

In a paper based on the examination of several thousand lepers, Johnston commented on the varying morphology of the bacillus of leprosy. He concluded that examination of nasal mucus is of no value as a routine measure. Perkins discussed the chemistry of some drugs used in the treatment of leprosy. He also presented details regarding the manufacture of ethyl esters of chaulmoogra oil at the Bureau of Science. At that time about 40,000 doses a month were being manufactured.

Gomez and his colleagues reviewed the subject of early leprosy in children of lepers. They concluded that there is real danger to children who live in intimate contact with lepers, an important fact not then well known. They further noted that the most frequent recognizable site of early lesions of leprosy is the skin and the most frequent early sign is a macular whitish or fawn colored patch. Schöbl and his colleagues attempted by experimental laboratory evidence to answer certain questions on the chemotherapy of infectious diseases caused by acid-fast bacilli. They found, among other results, that chaulmoogra oil and its derivatives exert a pronounced and specific growth-inhibiting action on *Bacillus tuberculosis in vitro*. Other vegetable oils also inhibit the growth of acid-fast organisms but not so effectively as those of chaulmoogra and *hydnocarpus*. The vapor of these two oils shows no disinfecting effect, however. Schöbl noted further that the growth-inhibiting activity of chaulmoogra oil depends on the structure of the ring of the fatty acids. When the structure of the ring is changed by saturation with hydrogen, the oil loses this biologic property. The acid-fast bacteria adapt themselves to the acids from the chaulmoogric series in due time and they withstand larger doses than they did originally. Saturated chaulmoogra oil lacks the growth-inhibiting activity toward acid-fast bacteria which is possessed by the unsaturated oil.

Callendar and Bitterman made an epidemiological study of leprosy in the Philippines. On the basis of the histories of some 259 lepers, they concluded that their evidence supported the view that the earliest lesion is an anesthetic area, that the organism probably enters the body through abrasions of the skin, that the more susceptible ages are in the first decades although no ages seemed exempt, and that further epidemiological studies in the Philippines are needed. Vedder emphasized the importance of further study of the possibility of insect born leprosy, demonstrating from an analysis of Philippine data that the evidence for transmission by contact is by no means complete. His three human experiments for transmission by *Aedes aegypti* were negative in the year of observation.

Schöbl and his colleagues demonstrated that advanced specific lesions can be produced by repeatedly inoculating Philippine monkeys with leprous material, and that these lesions closely resemble certain advanced lesions as known to exist in man. They noted a definite relationship between the forms and numbers of *B. leprae* and the stages of development of the advanced local skin lesions. Their experiments strongly suggested the possibility of studying certain phases of the course of leprosy infections and of immunological reactions by experiments on monkeys.

In 1931 the director of the Bureau of Science, Dr. William H. Brown, was elected treasurer of the newly organized International Leprosy Association at a meeting held in Manila.

BERIBERI

In 1905 Herzog, of the Bureau of Science, was sent to Japan to study beriberi. A great number of cases had accumulated in the military reserve hospitals during the Russo-Japanese war, in fact the total number of cases of beriberi in the army was said to be about 80,000. An unusual opportunity was therefore presented to investigate this disease, known at the time to be prevalent in the Philippines. Herzog experimented with the Okata-Kukubo coccus which was thought to be the cause. He brought it back to Manila and reported that it did not seem to meet the requirements of a causative organism in his own experiments with monkeys. Herzog later prepare a review of the literature of beriberi and reported a series of autopsies in Manila. He came to the conclusion, which was in accord with numerous other investigators at the time, that beriberi was an infectious disease. He also mistakenly believed that infantile beriberi was not common in Manila.

McLaughlin and Andrews investigated infant mortality in Manila and among other findings reported that what they would call "infantile moist beriberi" was responsible for many more deaths than appeared to be the case from statistics, in fact it was the largest factor in the infant mortality of Manila. They did not determine the cause, although it is interesting that they stated that "it seems probable that there is an intimate relation between beriberi of infants and a mother's milk, poor in quality and lacking certain necessary elements which are not included in the mother's dietary."

Chamberlain and Vedder, of the United States Army Board for the study of Tropical Diseases, had shown in a series of experiments, that the substance in rice polishings which prevents *Polyneuritis gallinarum* was present in an extract of the polishings and that this neuritis-preventing principle was soluble in cold water or cold 95 per cent alcohol. The phosphorus, inorganic salts, and sucrose in this extract were, by experiments, excluded from further consideration as regards the prevention of neuritis. In a third paper these Army investigators collaborated with Williams of the Bureau of Science and the previous findings were further substantiated.

Strong and Crowell wrote, in 1912, that the etiology of beriberi was still a matter of some controversy and that, although numerous experiments had been reported, in which fowls were used, there had been not a single experiment upon man which from a scientific standpoint could be regarded as a crucial test. The only exception was the work of Fraser and Stanton in Malaya. These workers had published very suggestive data but concluded that further research was needed. Therefore Strong and Crowell set about to determine definitely whether beriberi as occurring in the Philippine Islands was an infectious disease or whether it was one which had its origin in disturbances of metabolism, brought about by the prolonged use of polished rice as a staple article of diet. Their experiments were carried out on thirty-nine prisoners in Bilibid. They concluded from their studies that there was no evidence that beriberi was an infectious disease. Beriberi in their experiments was produced only by means of a diet lacking in some substance or substances necessary for the normal physiological processes of the body. Strong and Crowell noted that such substance or substances are evidently present in red rice and in rice polishings and also in a small amount in the alcoholic extract of rice polishings. These were notable experiments.

Vedder and Williams disproved experimentally the theory that beriberi may result from the use of undermilled rice which has been kept in a damp place. They found that even after a year's storage in a damp place undermilled rice still protected against *Polyneuritis gallinarum.* They succeeded in curing a case of wet infantile beriberi by administering that portion of an extract of rice polishings represented by filtrate from phosphotungstic precipitate.

Williams and Saleeby, experimenting with twenty-seven cases of human beriberi, concluded that "the vitamine of rice polishings possesses specific and prompt curative properties far beyond those of any other known substance." Their work was noteworthy in that they used human patients instead of fowls. Williams and Crowell showed experimentally that there is no apparent fundamental connection between beriberi and atrophy of the thymus, as had been suggested by others.

Wells described the method used by the Bureau of Science in the manufacture of tikitiki extract for beriberi which had proved so useful that the demand at that time called for 15,000 bottles a month. Fleming found no significant differences between surgical convalescents and beriberi patients as regards basal metabolic rates and respiratory quotients.

Vedder and Feliciano examined some 200 samples of rice from different localities and all degrees of milling in order to determine some standards regarding the prevention of beriberi. They found that no rice having 50 per cent or more of the external layers of the grain produced polyneuritis in pigeons. They also determined some chemical indices suitable for incorporation in legal regulations. Finally, their experiments made it seem probable that there may be a loss of vitamins from undermilled rice during long storage, due to the depredations of insects which have eaten the external layers of the grain.

YAWS

Woolley described some cases of a disease, called "lepra" by the Igorrotes, which he believed to be framboesia. Woolley's description is the first contribution of a long and very noteworthy series of papers on the subject of yaws by Bureau of Science personnel.

Ashburn and Craig, of the United States Army Board for the Study of Tropical Diseases, working in the Biological Laboratory of the Bureau of Science, were the first to prove that yaws was a fairly common disease in the Philippines. These investigators made fundamental and noteworthy studies.

Their work definitely proved that *Treponema pertenue* is the cause of yaws, and that it is constantly present in serum from yaws lesions. Moreover they demonstrated that monkeys can be infected with this organism, which can again be recovered from the simian lesions. By their study of yaws in monkeys they were able to conclude that yaws and syphilis are distinct diseases, and that the *Treponema pertenue* of yaws and *Treponema pallidum* of syphilis can be differentiated.

Marshall, in a histologic study, showed that the cellular pathology of simian and human yaws is essentially the same. In neither is there an endarteritis nor are there any other changes suggestive of syphilis. Strong received from Ehrlich a shipment of dioxydiamido-arsenobenzol for experimental purposes with syphilis. When in Frankfurt, Strong had made arrangements with Ehrlich that he would send to the Bureau various new preparations to test their value for tropical affections. Because of the similarity between yaws and syphilis, Strong tried this new drug in cases of yaws. He demonstrated that the drug was an ideal specific for yaws. Bowman confirmed and supplemented Castellani's experiments with specific yaws antibodies and antigen, thus furnishing additional evidence as to the non-identity of syphilis and yaws.

Sellards, of the Bureau of Science, and Goodpasture and de Leon, of the College of Medicine, were associated in some investigations which included a study of the Wassermann reaction in yaws and the effect of treatment on this diagnostic test, the subject of immunity, the histology of healing lesions and, finally, the public health aspects of this disease, with suggestions for its control. They concluded that yaws was the one outstanding disease of the Tropics through the treatment of which the immediate confidence and enthusiasm of the people can be secured in public health work. This observation had since been abundantly confirmed in many tropical countries.

Lacy and Sellards, as a result of some inoculation experiments with human subjects, made a point, of practical significance, that yaws patients, treated in the advanced secondary stage of infection, remained in excellent health, free from any symptoms of yaws, and that they retained well-marked resistance to reinfection for more than two years. Such a period of time is enough to permit bringing the disease under control even in heavily infected districts. Sellards, Lacy, and Schöbl demonstrated in human volunteers that, in contrast to syphilis, superinfection with yaws is possible, even after the typical primary granuloma has developed. These investigators also described some uncommon skin manifestations of yaws, concluding that, contrary to the usual belief, yaws may show almost as varied cutaneous lesions as syphilis.

Schöbl and Ramirez described experiments with the globulin precipitin reaction in which its independence of the Wassermann reaction was demonstrated and its practical value as a confirmatory test of clinical yaws in the pre-Wassermann stage was suggested.

Lopez-Rizal and Sellards found yaws widespread in the Mountain Province and noted that the cutaneous lesions, as seen in the mountain people, are peculiar in that they are usually limited to the mucocutaneous junctures of mouth, nose, anus, and genitalia.

Schöbl, in 1928, published a most important paper dealing with yaws. He clearly pointed out, in a lengthy and critical analysis of the literature, that although Castellani discovered the *Treponema pertenue* of yaws in 1906–07 yet twenty years later the mode of transmission of the disease among humans was not clear, the question of immunity was unsettled, and the question of the relation of yaws to syphilis still awaited an answer. He concluded that the local lesion produced by intradermal inoculation, as well as the early metastic lesions of superinfection and the late yaws manifestations, like gangosa, are, in Philippine monkeys, clinically and anatomically identical with the corresponding lesions in man; the inoculation periods also are similar. Schöbl noted, further, the very important fact that the healing of existing yaws lesions, particularly the early ones, is independent of the resistance to superinfection. That is to say, yaws lesions in monkeys, as in men, may heal while the animal or man is still susceptible to superinfection, and existing lesions will persist a long time after the stage of resistance to superinoculation has fully developed. Once the resistance to superinfection has been achieved, it is persistent, and no amount of treatment can cause the animal, once it has become resistant, to take infection again.

Yasuyama studied the viability of *Treponema pertenue* and published some original experimental data of importance. He found that the organism of yaws is unable to survive at low temperatures (0 to 5°C.) for more than 30 minutes, a fact which may explain why yaws, when introduced into a cold country, does not become endemic. Yasuyama found body temperature (37°C.) more favorable than room temperature. The viability of the organism outside the body was found to be limited to a few hours. In and on the bodies of flies the period of viability was found to be about thirty minutes.

Tanabe studied the Wassermann reaction in yaws in monkeys, concluding that such animals are suitable for the experimental study of this reaction. Alcohol was found to have the same effect on the Wassermann test in yaws as in syphilis. This constituted further proof of the identity of the reaction in Philippine monkeys and in syphilitic patients. Tanabe showed that when yaws has healed in monkeys, the immunity to reinoculation lasts longer than two years and probably for life.

Schöbl, Tanabe, Miyao, and Garcia studied certain serologic changes as they occurred in experimental framboesia in Philippine monkeys. They had found that when normal monkeys were injected subcutaneously with yaws material in such a manner that the development of skin lesions was prevented, the monkeys showed a strong Wassermann reaction although they did not become infected with yaws. They do not have a latent infection of the internal organs. As a matter of fact, subcutaneous injections of killed *Treponema framboesiae* will produce this strong Wassermann reaction, which, after repeated injections, becomes weaker and finally negative. But injections of normal or inflammatory skin tissue from normal or yaws-infected monkeys, as well as injections of potent yaws vaccine, not containing treponemas, will not produce a positive Wassermann reaction. It was demonstrated that the skin tissues proper and not the lymphatic system or the muscles are responsible for the production of the Wassermann reagin. There is a positive reaction to the Kahn test in Philippine monkeys infected with yaws. The experiments indicated that the reagin of the Wassermann reaction is a true antibody of its kind. It is a direct serologic response to the antigen contained in the treponema and not merely a consequence of interaction between the viable treponemas and the tissues.

Although the close relationship between syphilis and yaws has been apparent for many years, very few experiments have been conducted to determine the immunologic reciprocity between these two diseases. Until Schöbl and his coworkers attacked the problem, there was no sound experimental evidence of any cross-immunity, in fact most workers in this field had convinced themselves that neither disease immunized against the other. It was Schöbl who noted that, although yaws monkeys (local yaws) were without exception inoculable with yaws for five months after the first inoculation, animals superinfected after the sixth month were, without exception, immune. During the sixth month only a certain percentage were immune. Furthermore, monkeys with generalized yaws were immune earlier than those with local yaws, while in animals with late ulcerative lesions, the immunity was much delayed. Schöbl and Miyao, using only monkeys which had been successfully inoculated with yaws more than twelve months previously and which were proved to be immune to yaws, demonstrated conclusively that a high degree of immunity to yaws protects against cutaneous infection with syphilis in Philippine monkeys. Here was research of the highest order.

Schöbl and his confreres continued their yaws experiments, showing more and more clearly that there is a definite serologic reciprocity between yaws and syphilis. They noted that immunity to yaws produced by yaws vaccination prevented development of a specific syphilitic lesion, but did not necessarily prevent the penetration of treponemas of syphilis into regional lymph glands corresponding to the point of inoculation with syphilis. They repeatedly stressed the biologic difference between *Treponema framboesiae* and *Treponema luis*. The difference is one of organotropism or tissue selectivity. The treponema of syphilis is panblastotropic with a mesoblastic preference, being able to invade, multiply, or colonize all tissues. The treponema of yaws is epiblastotropic, invading, colonizing, and producing lesions only in certain tissues, particularly the skin. It may invade the mucous membrane by extension "*per continuitatem*" from the skin.

Schöbl's continued experimentation added confirmation to his earlier finding that immunity to yaws gained by yaws infection protects Philippine monkeys against cutaneous inoculation with syphilis.

Miyao reviewed the whole question concerning the relationship of yaws to syphilis, with a view to determining whether or not they are nosologic entities. He concluded that the two diseases belong to one group and show a close relationship, but that they are fundamentally distinct. As was noted above, there is a basic biological difference in the organotropism of the two treponemas.

Schöbl demonstrated that the immunologic reciprocity between yaws and syphilis is a group immunity not dissimilar to that group relationship known to exist in bacterial immunity. Monkeys infected with syphilis became immune to syphilis much sooner than they did to yaws and monkeys infected with yaws became immune to yaws sooner than to syphilis. Immunity to syphilis, like immunity to yaws, seems to last throughout the natural life of Philippine monkeys. The antitreponematous immunity in vaccinated monkeys that had been proved immune to skin inoculation with yaws and syphilis was shown to be of as long duration as the immunity induced by infection accompanied by specific skin lesions. Vaccine therapy with killed syphilis vaccine, performed on yaws-infected and early-treated monkeys, accelerates the onset of immunity to yaws. Infection with syphilis immunizes Philippine monkeys against yaws. Mesodermal inoculation with yaws immunizes against epidermal infection with yaws.

Schöbl, on the basis of his seven years' study of experimental yaws and syphilis in monkeys, offered an interpretation of the laws of Brown and Pearce. These laws were deduced by the authors as a result of their studies of experimental syphilis in rabbits. The law of inverse proportions, to the effect that the more intensive the early manifestations the less intensive the late manifestations, was interpreted by Schöbl as a direct proportion between the quantity of treponematous antigen, dead or alive, and the degree of immunity and the speed of its development. The law of sequence, to the effect that the various systems of tissues are affected successively, was interpreted by Schöbl as a successive development of immunity in the various systems of the body's tissues. This view, based on Schöbl's extensive and intensive studies, brought the laws of Brown and Pearce into agreement with the laws governing antibacterial immunity and constituted a noteworthy contribution to the knowledge of tissue immunity. Schöbl predicts that the question of organotropism with regard to infection and immunity very likely will be found to have a more general application than is suspected today.

Conceptions of immunity must be modified as a result of Schöbl's work. Moreover, as a result of Schöbl's monumental researches in the treponematoses, we may hope that one day vaccination will be a practical weapon in our attempts to combat yaws and syphilis, more particularly, of course, the latter. Surely we may class these biological studies of Schöbl and his associates at the Bureau of Science as among the best in the history of medical research throughout the scientific world.

MISCELLANEOUS

This review would far exceed the limits set for it if all the papers resulting from medical research at the Bureau of Science were reviewed even as briefly as those already mentioned. It must suffice to note that the investigations at the Bureau have delved into every phase of medicine as it concerns life and health in the Philippines. For example, there have been surveys and studies in trematode infestations by Woolley, Musgrave, Phalen and Nichols, Garrison and Leynes, and culminating in the researches of Tubangui, who has traced, for the first time, the life cycle of the Schistosomiasis parasite as it is found in the Philippines. Skin infections and ulcerations have been studied by Strong, Musgrave, and Clegg, Shattuck, Lefebvre, Schöbl, and others. Filariasis surveys were made by Phalen and Nichols and by Walker. Smallpox was studied by Brinckerhoff and Tyzzer, of the Harvard Medical School Smallpox Commission, who added much to the world's knowledge of this disease.

Musgrave and Sison published clinical data, and Crowell added some notes on pathology, regarding the bone lesions of smallpox. These lesions are typical and although recently described again by others were first noted by these authors.

Malaria and *Anopheles* mosquitoes have been investigated by Walker and Barber, by Baisas, King, and others. McKinley prepared an exhaustive monograph on filterable viruses, making use of the unexcelled facilities of the Bureau of Science library.

Barber, in 1914, published the perfection of his highly original and notable method of isolating single organisms under microscopical control by means of a very fine-pointed, capillary pipette of glass. Barber's technique prepared the way for the numerous micro-manipulators now available.

Fleming has studied tropical light, and there have been many important researches into the etiology and clinical manifestations of dengue by members of the Medical Department Research Board of the United States Army while working at the Bureau of Science.

Intestinal parasitism has been investigated in the field and in the laboratory by Bowman, Willets, Rissler and Gomez, Gomez, Walker, Crowell and Hammack, and by Leach, Schwartz, and Haughwout.

Investigations were made of Philippine foods and foodstuffs, particularly of soy bean and rice bran, culminating in the contemporary and notably practical publications of Miss Orosa.

Vazquez-Colet and also Schöbl, Hirano, Ramirez, and Arima have studied rat-bite fever. Schöbl's observation that the distribution of rat-bite fever in Manila coincides with that of plague during the last epidemic is of particular significance.

A perusal of the appended bibliography will reveal many other papers of unusual interest.

It would require more space than is available to do justice to these miscellaneous papers, many of which had unique value. All-in-all, the record of the Bureau of Science, Manila, is one of real achievement in the field of tropical biology and medicine. Musgrave, in his review in 1911 of the progress of medical research in the Philippines, did not exaggerate when he wrote that

> Research and investigation have made successful public health administration possible in this country, and the availability and convenience at all times of a trained corps of investigators to the administrators of public health affairs has resulted in an unusually high scientific plane of campaign of preventive medicine.

SUMMARY

This paper reviews the history of the Philippine Bureau of Science. It discusses the biological and medical research which has been done at this institution since 1901. It calls attention to the fact that routine work and research have been blended at the Bureau of Science to the advantage of each.

The paper notes certain fundamental advances which have resulted from studies by personnel of the Bureau in the field of tropical medicine, especially in beriberi, cholera, plague, bacillary and amoebic dysentery, leprosy, and yaws. An extensive bibliography is appended.

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THE FIRST MAMMALS

By GEORGE GAYLORD SIMPSON

THE Cenozoic Era, or sometimes more narrowly the Tertiary Period, of the geologists is popularly known as the Age of Mammals. The name is apt, but it may be misleading. Mammals did not arise at the beginning of this Age of Mammals. Recent estimates would place the latter date at about 60,000,000 years ago, and would give at least 180,000,000 years for the present age of the Class Mammalia. Whatever the value of the exact figures, it is unquestioned that the entire Age of Mammals includes less than a third of the time during which mammals have existed.

More important still, this so-called Age of Mammals includes only the last part of mammalian history. When it dawned, the evolutionary progress and fundamental differentiation of the Mammalia were already about two-thirds complete. The student of recent mammals deals with relatively static, completed products. The student of Tertiary history, so far as the record is available, can trace the origin of modern species, genera, and families, but the primary differentiation of the class and even the origin of the orders elude him. At the beginning of the Tertiary, in the Paleocene and Eocene epochs, the orders of mammals were already distinct, although they were still so similar in some respects that their divergence may not have been long antecedent, geologically speaking.

The fundamental evolution of the Mammalia, so important to any student of mammalogy, was entirely pre-Tertiary. It belongs to mammalian pre-history, to the vast span of the Mesozoic Era. This era is famous as the "Age of Reptiles," in deference to its rulers, but in a very real sense it was also an age of mammals, for the higher class was in existence throughout the greater part of the era and, although quite obscure, was then undergoing a part of its evolution so essential that the more spectacular Tertiary developments almost seem a mere elaboration of what had already been plotted.

The study of origins is always peculiarly difficult. The later dominant and large mammals have left abundant, even if not complete, records. The struggle for their inherited advantages, on the contrary, and the acquisition of the characters and potentialities which led to their supremacy were undergone by small beasts crushed beneath the weight of reptilian hordes. The grand destiny of these precursors could never have been imagined. They were of little apparent importance in the economy of the age. They led obscure lives and in contemporary records they left little trace of their existence. These were the Mesozoic mammals.

Even after the significance and general sequence of fossil animals was beginning to be appreciated, the existence of Mesozoic mammals was at first unsuspected or denied. It was about 1812 when a fossil jaw, imbedded in a rock of Jurassic age, was found by "an ancient stonemason" near Oxford in England and, through W. J. Broderip, then a student, brought to the attention of Professor Buckland. This was a mammal jaw and it came from a deposit formed at a time when, according to the geologic theory of that day, no mammals existed. By 1824 the future dean's convictions had conquered his cautious orthodoxy and he announced the discovery. By 1840, after a storm of discussion, it was universally accepted.

Many other specimens of Mesozoic mammals have since been found, but they still remain by reason of their rarity and significance among the most precious of fossils, and by reason of their imperfections among the most difficult to study and to interpret. The collections are relatively small, certainly not one thousandth as large as those which represent the much shorter Tertiary history of mammals. It would be ridiculous to expect the materials in hand to answer all of the vital questions naturally referred to them, but it seems equally clear that any student of life should know something more of the existence and of the character of these materials than has been generally available. Details regarding the subject have been given by the present writer, chiefly in two memoirs (Simpson, 1928A, 1929) which describe most of the known specimens and give complete bibliographies. The aim of the present paper is to give a brief résumé, free of cumbersome details of interest only to the specialist, which may aid mammalogists and biologists in the general understanding of the subject.

About fifteen museums contain some significant specimens of Mesozoic mammals, but the collections of paramount importance are four in number: that in the British Museum (Natural History), chiefly described by Sir Richard Owen (1871) and by Henry Fairfield Osborn (1888); the collection in the Peabody Museum of Yale University, made for and described by Professor Marsh (1887, 1889, 1892); a smaller collection with the same history in the United States National Museum; and the material in the American Museum of Natural History, in small part from the collection of Professor Cope, but chiefly from Museum expeditions, originally described by Osborn, Matthew, Gregory, and the present writer. The specimens in these collections are chiefly isolated jaws and teeth, but a few more complete skulls make important exceptions and there are also some isolated skeletal parts.

CLASSIFICATION

Any phyletic line must meet one of three fates with the passage of time: it may die out without issue, or it may be modified until its members differ considerably from their ancestry, or it may survive with relatively little change. Historically, our accepted system of mammalian classification was based in the first instance on the successful lines only, on those which survive today. As fossil mammals were discovered, it was generally (and very properly) attempted to fit them into the groups exemplified by recent forms. Now, however, it is common knowledge that if we go back to the beginning of the Tertiary, not long after the ordinal differentiation of the Eutheria, we find along with the orders of the recent system others which will not enter into a classification based on living animals only. Some of the lines of this original eutherian divergence died out without issue and others have been almost unrecognizably changed.

Going still farther back to the very remote time of the original differentiation of the Class Mammalia, the same difficulty is found. As more and more data accumulate, the earlier almost universal tendency to force all the Triassic and Jurassic mammals into orders, superorders, and subclasses based only on the few lines that survived some six or eight score millions of years to the Recent, or even some three score into the early Tertiary seems to be doomed to eventual failure. There are some Jurassic mammals which clearly belong in or near these favored groups, notably the Pantotheria (see below).

Close analysis of what is known of other groups, such as the Triconodonta or Multituberculata, shows that they will not readily enter into even the larger divisions of the recent system and that the evidence usually cited for so placing them is erroneous or equivocal. The eventual major division of the Mammalia must abandon exclusive devotion to those which happened to survive and must take cognizance of the earliest mammals.

It is patent that data for radical revision are still inadequate, but more is known of Mesozoic mammals than is usually supposed. The coördination with later mammals on a basis recognizing their distinction, isolation, and importance is worthy of an attempt which, however tentative and impermanent, should be interesting and perhaps useful. Such an attempt is here presented in outline. The phylogenetic views on which it rests are briefly discussed below.

CLASS MAMMALIA
  SUBCLASS PROTOTHERIA
    Order Monotremata
  SUBCLASS ALLOTHERIA
    Order Multituberculata
  SUBCLASS THERIA
    INFRACLASS PANTOTHERIA
      Order Symmetrodonta
      Order Pantotheria (*sensu stricto*)
    INFRACLASS METATHERIA
      Order Marsupialia
    INFRACLASS EUTHERIA
      Orders, various
  Incertæ sedis: Order Triconodonta

For convenience, a family classification of the more typically Mesozoic orders is also given:

ORDER MULTITUBERCULATA
  SUBORDER TRITYLODONTOIDEA
    Family Tritylodontidæ
  SUBORDER PLAGIAULACOIDEA
    Family Plagiaulacidæ
    Family Ptilodontidæ
    Family Tæniolabididæ
  ?Multituberculata *incertæ sedis*: Family Microcleptidæ
ORDER TRICONODONTA
  Family Triconodontidæ
ORDER SYMMETRODONTA
  Family Spalacotheriidæ
  Family Amphidontidæ
ORDER PANTOTHERIA
  Family Amphitheriidæ
  Family Paurodontidæ
  Family Dryolestidæ
  Family Docodontidæ

DISTRIBUTION

The localities where remains of Mesozoic mammals have been found are relatively few and widely scattered. They represent only a small proportion of the actual geographic range of these groups, and they also represent a rather limited part of Mesozoic time. Furthermore, the majority of these occurrences have yielded few and very imperfect specimens. Fortunately, however, they are so situated in space as to give some conception of geographic distribution and in time as to give important vistas of mammalian life at several strategic periods in the early history of the class.

The accompanying map (Fig. 1), Figs. 2 and 3 and table 1 sum up the essential facts of known geographic and geologic distribution.

TRIASSIC MAMMALS

The oldest known mammals come from the late Triassic and from transitional Triassic-Jurassic rocks in England, Germany, and southern Africa (In addition to the memoirs cited above, see: Simpson, G. G., 1928B; Huene, E. von, 1933). They belong to two groups, the Tritylodontidæ and the Microcleptidæ. The former is known chiefly from the front part of a single skull from South Africa, type of *Tritylodon longævus* Owen, now preserved in the British Museum. It is relatively large for a Mesozoic mammal,

TABLE 1

Distribution of Mammals in the Mesozoic

	TRIASSIC			JURASSIC			CRETACEOUS		TERTIARY
	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Upper	
MULTITUBERCULATA									
TRITYLODONTOIDEA									
Tritylodontidæ			—	……	—				
PLAGIAULACOIDEA									
Plagiaulacidæ						—	—		
Ptilodontidæ								—	—
Tæniolabididæ									—
Inc. sed.									
Microcleptidæ			—						
TRICONODONTA									
Triconodontidæ					—	—			
SYMMETRODONTA									
Spalacotheriidæ						—			
Amphidontidæ						—			
PANTOTHERIA									
Amphitheriidæ					—				
Paurodontidæ						—			
Dryolestidæ						—			
Docodontidæ						—			
MARSUPIALIA									
Didelphiidæ								—	—
INSECTIVORA									
Zalambdalestidæ								—	
Deltatheridiidæ								—	— ? —
Leptictidæ								— ? —	—

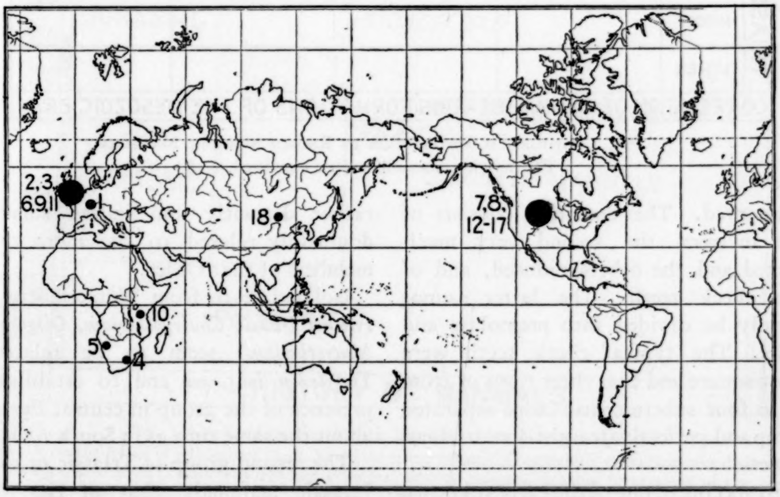
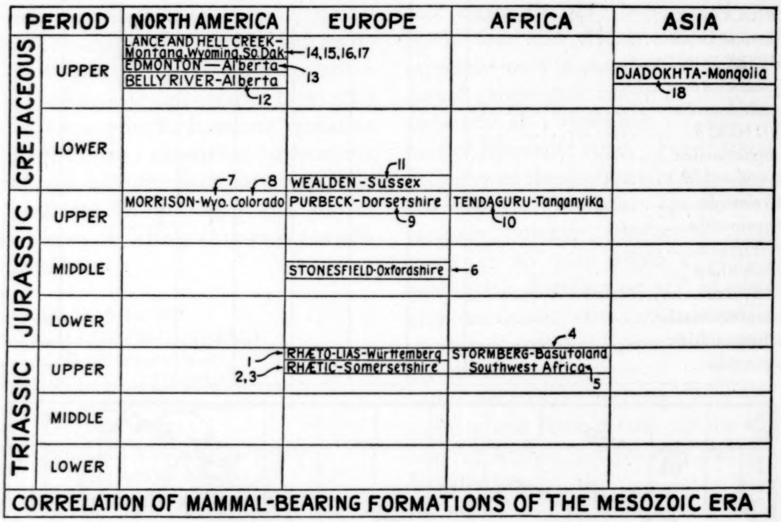


FIG. 1. GEOGRAPHIC DISTRIBUTION OF KNOWN MESOZOIC MAMMALS
The numerals correspond with those on Fig. 2

the skull probably over fifteen centimeters in length when complete. The sagittal crest is high and stout, the zygomatic arches arise opposite the anterior cheek teeth, and the snout is blunt, somewhat depressed, and expanded at the end. Septomaxillary bones, seldom recognizable in recent mammals, are present between the nasals, maxillaries, and premaxillaries, but in spite of occasional statements to the contrary no exclusively reptilian osteological characters are shown by the skull as preserved. The dentition consists of three incisors, the second very much enlarged and the others reduced, and of seven cheek teeth. The latter cannot certainly be divided into premolars and molars. The typical cheek teeth were almost square and bear three rows of from two to four subcrescentic cusps separated by deep and perfectly straight longitudinal grooves.



PERIOD		NORTH AMERICA	EUROPE	AFRICA	ASIA
CRETACEOUS	UPPER	LANCE AND HELL CREEK-Montana, Wyoming, So. Dak. ← 14,15,16,17 EDMONTON—Alberta ← 13 BELLY RIVER-Alberta ← 12			DJADOKHTA-Mongolia ← 18
	LOWER	7, 8	WEALDEN-Sussex ← 11		
JURASSIC	UPPER	MORRISON-Wyo. Colorado	PURBECK-Dorsetshire ← 9	TENDAGURU-Tanganyika ← 10	
	MIDDLE		STONESFIELD-Oxfordshire ← 6		
	LOWER				
TRIASSIC	UPPER	1 → 2,3 →	RHÆTO-LIAS-Württemberg RHÆTIC-Somersetshire	STORMBERG-Basutoland ← 4 Southwest Africa ← 5	
	MIDDLE				
	LOWER				

CORRELATION OF MAMMAL-BEARING FORMATIONS OF THE MESOZOIC ERA

FIG. 2. GEOLOGICAL DISTRIBUTION OF KNOWN MESOZOIC MAMMALS
The individual occurrences are numbered, 1–18

This specimen, one of the earliest known mammals, is among the most complete from the whole Mesozoic, yet its affinities have long been in dispute. Its mammalian character, once questioned, seems well established, unless our conception of the class be radically changed. It is generally and with fairly good evidence referred to the Multituberculata, but it is very different from any later multituberculate with a single exception (mentioned below). The most satisfactory view at present seems to be to consider it as in an early side branch (suborder) of the Multituberculata, rather distantly and indeed somewhat doubtfully related to the more typical members of that Order.

Isolated teeth from Württemberg (*Tritylodon fraasi*, *Chalepotherium*, *Oligokyphus*, *Mucrotherium*) seem to be related to *Tritylodon longævus* and to establish the presence of the group in central Europe at about the same time as in South Africa.

The second group of Triassic or earliest Jurassic mammals, that of the Microcleptidae, is known only by isolated teeth from Somersetshire in England and Württemberg in Germany. These teeth are very small, generally about two millimeters in length, and the crowns have an elongate valley surrounded by a cuspidate rim, the cusps unequal in size and less

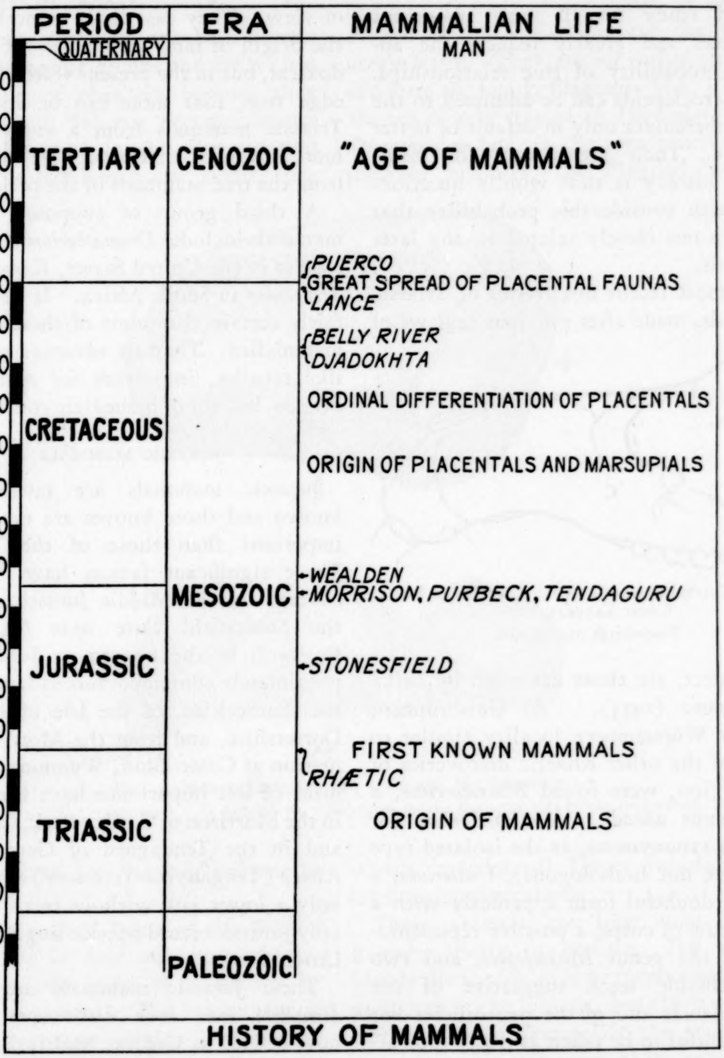


FIG. 3. OUTLINE OF THE MAJOR EVENTS IN MAMMALIAN HISTORY

The scale on the left is in millions of years, based on recent estimates (especially on radioactive disintegration of minerals). In the right hand column the principal known mammal-bearing formations of the Mesozoic (and Puerco, earliest Cenozoic) are given in italic capitals and the principal historical events, in part inferred, in roman capitals.

numerous on one side than on the other. It was at one time believed that these teeth were very like those of upper Jurassic multituberculates, but renewed and more detailed study reveals very important differences and greatly reduces the apparent probability of true relationships. The microcleptids can be admitted to the Multituberculata only in default of better evidence. Their significance for mammalian history is thus wholly questionable, with considerable probability that they are not closely related to any later mammals.

The most recent discoveries of Triassic mammals, made after previous reviews of the subject, are those described by Erika von Huene (1933). At Gaisbrunnen, another Württemberg locality similar to those of the other Rhaetic discoveries of that region, were found *Mucrotherium*, a new genus allied to *Chalepotherium* (or perhaps synonymous, as the isolated type teeth are not homologous), *Uniserium*, a wholly doubtful form apparently with a single row of cusps, a possible representative of the genus *Microcleptes*, and two unidentifiable teeth suggestive of the plagiaulacids and of the pantotheres but too doubtful to be taken as really indicating the presence of those groups. These very interesting discoveries suggest that the mammalian fauna was more varied than previously indicated, but they hardly advance exact knowledge of its nature.

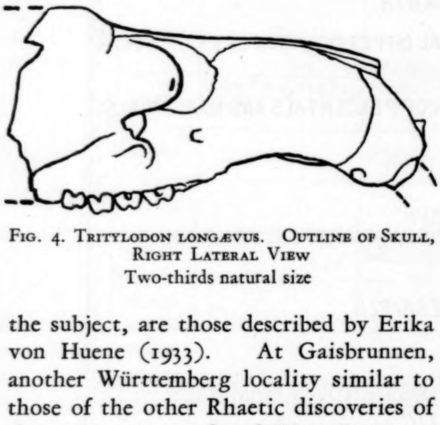


FIG. 4. TRITYLODON LONGÆVUS. OUTLINE OF SKULL, RIGHT LATERAL VIEW
Two-thirds natural size

These Triassic assemblages are distinctly disappointing from a phylogenetic point of view. They cast little or no light on the origin of later mammals. It is paradoxical, but in the present state of knowledge true, that more can be learned of Triassic mammals from a study of the more advanced theromorph reptiles than from the true mammals of the period.

A third group of supposed Triassic mammals includes *Dromatherium* and *Microconodon* in the United States, *Karoomys* and *Tribolodon* in South Africa. It now seems fairly certain that none of these is really mammalian. They are advanced mammal-like reptiles, important for mammalian origins, but not of immediate concern here.

JURASSIC MAMMALS

Jurassic mammals are much better known and those known are much more important than those of the Triassic. Three significant faunas have been discovered: in the Middle Jurassic, that of the Stonesfield slate near Oxford in England; in the uppermost Jurassic approximately contemporaneous faunas from the Purbeckian of the Isle of Purbeck, Dorsetshire, and from the Morrison Formation at Como Bluff, Wyoming. Specimens of less importance have been found in the Morrison of Garden Park, Colorado, and in the Tendaguru of German East Africa (Tanganyika Territory)—the latter only a lower jaw without teeth, but the only Jurassic record outside England or the United States.

These Jurassic mammals are readily divisible into four distinctive groups, now defined as Orders: Multituberculata, Triconodonta, Symmetrodonta, and Pantotheria. The last three are confined to the Jurassic, but Multituberculates survived through the Cretaceous and Paleocene into the Eocene.

Jurassic Multituberculates

Multituberculates are the best known of all the Mesozoic groups and are no less characteristic of that era because they survived it and did not become extinct until the Eocene. In the Jurassic two sorts of multituberculates occur, one group in the Middle Jurassic and one in the Upper.

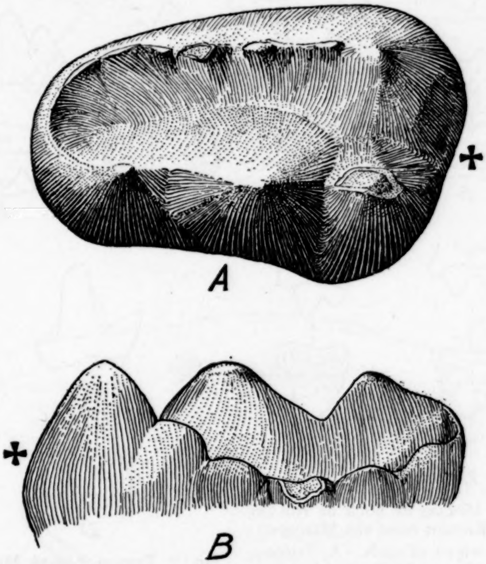


FIG. 5. MICROCLEPTES MOOREI, A RHÆTIC MICROCLEPTID

Isolated tooth. A, Crown view. B, Side view. The cross marks the same end in the two views. Thirty times natural size.

In the Stonesfield fauna of the Middle Jurassic there is only one multituberculate, *Stereognathus*, and it is known by only two specimens. The interpretation of its fragmentary remains is doubtful, but they probably represent the upper jaws of an animal allied to the Triassic *Tritylodon*. The teeth are quadrate, with three longitudinal rows of two cusps each.

In the Upper Jurassic English Purbeckian and American Morrison, on the contrary, multituberculates are fairly numerous. Several genera occur, of which *Plagiaulax* and *Ctenacodon* are the most noteworthy. They are all rather similar and form the family Plagiaulacidæ. They are not closely related to *Tritylodon* or to *Stereognathus* but are the forerunners of a separate suborder, the Plagiaulacoidea, which includes all Upper Jurassic and later multituberculates.

These animals are like none other known, living or extinct. The skull, highly distinctive in later forms, is almost unknown in the Jurassic, but the jaws and teeth define and exemplify the primitive and distinctive characters of the suborder. The lower jaw is short, stout, inclined downward in life. The coronoid process is small, and there is no true angular process, the pterygoid muscles both being inserted along a continuous, non-angulate crest on the inner side of the jaw. The single pair of lower incisors is enlarged, while in the upper jaw there are three pairs, the second being enlarged as in *Tritylodon*. The lower premolars are three or four in number in the plagiaulacids and together they form a compressed shearing wall with serrated apex and crested sides. There are five upper premolars, the first three triangular, with three conical cusps, not opposing the lower premolars, the last two larger, with more numerous cusps in two rows, forming an upper shearing edge opposed to the lower premolars.

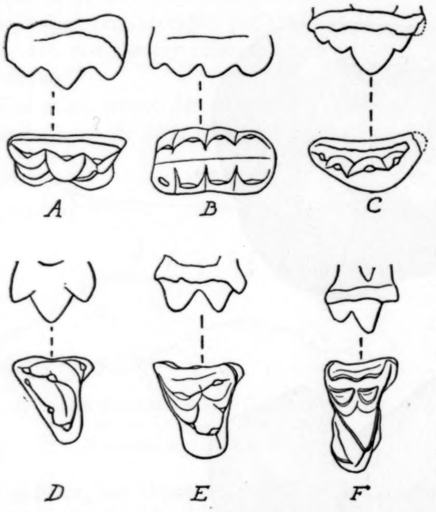


Fig. 6. Typical Upper Molars of Each of the Six Orders of Mammals Known from the Mesozoic

External and crown views of each. A, Triconodonta (*Priacodon*, Upper Jurassic). B, Multituberculata (*Ctenacodon*, Upper Jurassic). C, Symmetrodonta (*Eurylambda*, Upper Jurassic). D, Pantotheria (*Melanodon*, Upper Jurassic). E, Marsupialia (*Pediomys*, Upper Cretaceous). F, Insectivora (*Gypsonictops*, Upper Cretaceous). Not to scale.

Were it not for the contradiction in terms, the plagiaulacids might be called paucituberculate multituberculates, for their molars have only from five to eight cusps, not numerous as compared with most other mammals. The arrangement, however, is more essential than the number and this is characteristic: on each molar they occur in two longitudinal rows of from two to four cusps each, separated by a longitudinal groove. An apparently abnormal character, but one with a definite bearing on the origin of later multituberculate molar types, is seen in the fact that the two upper molars are so placed that the outer row of the second is in line with the inner row of the first.

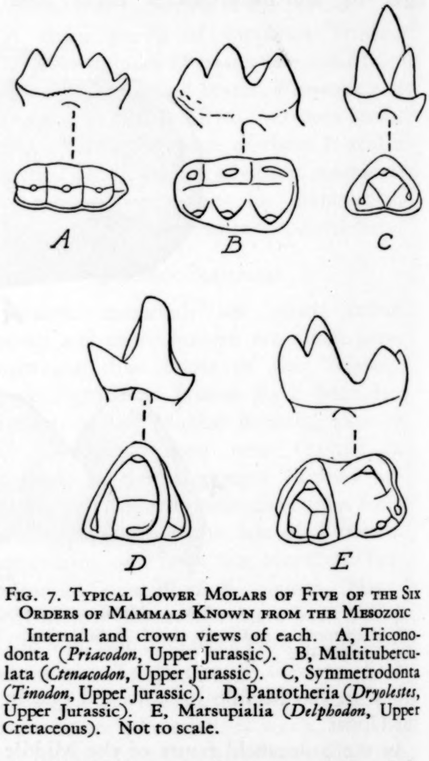


Fig. 7. Typical Lower Molars of Five of the Six Orders of Mammals Known from the Mesozoic

Internal and crown views of each. A, Triconodonta (*Priacodon*, Upper Jurassic). B, Multituberculata (*Ctenacodon*, Upper Jurassic). C, Symmetrodonta (*Tinodon*, Upper Jurassic). D, Pantotheria (*Dryolestes*, Upper Jurassic). E, Marsupialia (*Delphodon*, Upper Cretaceous). Not to scale.

This type of dentition has three localized functions: piercing and holding by the enlarged incisors, cutting by the premolars, and grinding by the molars. It is an interesting and very peculiar arrangement, the use of which, so far as may be inferred, seems to be for a diet of seeds, small fruits, and other vegetable food, (see Simpson, 1926), although the opposite view of carnivorous habits has also been maintained.

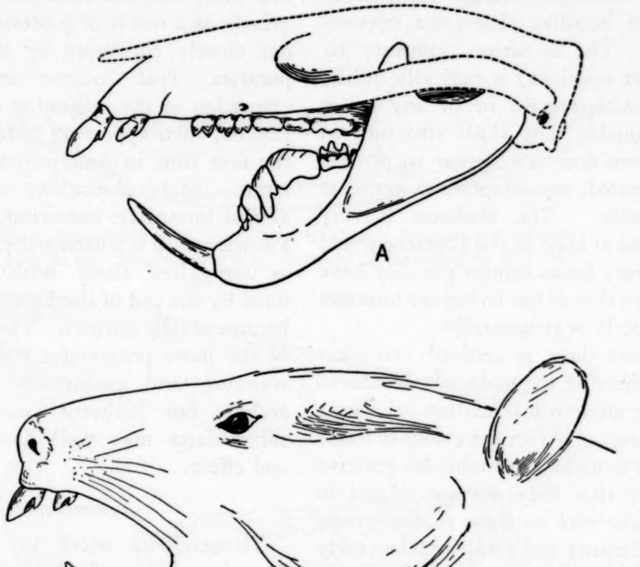


FIG. 8. CTENACODON, AN UPPER JURASSIC PLAGIAULACID

A, Reconstructed skull and jaws; the parts in continuous lines are a composite of all known specimens and those in broken lines are conjectural or based on related genera. B, Tentative life restoration; based on the accompanying skull reconstruction and on a careful restoration of the jaw musculature. Three times natural size.

The multituberculates are known in most detail from post-Jurassic specimens, but conclusions based on all the materials may be expressed here as equally applicable to the Jurassic forms. At least a dozen views as to their affinities have been advanced, and these differ not merely in detail but even as to the subclass to which the Order belongs. Multituberculates have been considered as especially related to the placentals, to the marsupials, and to the monotremes, as well as to all and none of these. Where such definite relationship has been supposed to occur, no two students have agreed as to its degree or kind. However, the great recent advance in knowledge of this group seems to reduce the theories now reasonably tenable to two: the multituberculates are either related to the ancestry of the monotremes, or they are a sidebranch of the Mammalia distinct since the very beginning of the Class.

The arguments are complicated by the

relatively large number of facts now known about various multituberculates. Resemblances to the monotremes are seen in certain (rather superficial) cranial characters such as the reduction of the lachrymals and jugals, in the absence of a mandibular angular process, the position of the external auditory meatus, etc. On the other hand an almost insuperable complex of peculiar characters opposes this view. The dentition (contrary to some earlier opinions) is radically unlike that of *Ornithorhynchus* or of any other later mammals. The skull structure so far as known does not appear to present any deep-seated, non-adaptive monotreme characteristics. The skeleton is very different and at least in the Cretaceous and early Tertiary forms cannot possibly have given rise to that of the living monotremes even indirectly or structurally.

At present there is certainly no clear basis for referring the multituberculates to any of the modern mammalian subclasses or infraclasses. In fact the evidence seems sufficiently complete to establish a positive probability that they are not related in any intimate way to these recent groups but are a distinct and totally extinct early offshoot of the Class as a whole. If this is true, its only convenient taxonomic expression is the rather radical step, briefly suggested by Granger, endorsed by Matthew, and strongly supported by the present writer, of placing them in a separate subclass, the Allotheria.

Although its members never reached great size and although they are so little known to recent zoologists, the multituberculates formed one of the greatest mammalian orders. Their recorded duration was as long as for any other mammalian order and during this time they spread over most of the world, attained considerable variety in size and character, and occupied a commanding position in early mammalian assemblages.

Why such a long-lived and outstanding group did become extinct in the Lower Eocene is perhaps all too fertile a ground for speculation, but there is an interesting possibility. Functionally, although not anatomically, the multituberculates closely resemble the rodents. It is probable that their ecologic position was similar and that, like the rodents, they thrived greatly as a result of possessing a habitus not closely paralleled by their contemporaries. True rodents underwent an expansion at the beginning of the Lower Eocene, then appearing suddenly and for the first time in American and European strata. Multituberculates underwent an almost immediate reduction, so far as the known record is trustworthy, but survived as stragglers along with the rodents until by the end of the Lower Eocene they became totally extinct. The introduction of the more progressive rodents and the wanning and extinction of the very archaic but hitherto successful multituberculates may well have been cause and effect.

Triconodonts

Triconodonts occur in three known deposits: Stonesfield, Purbeckian, and Morrison. Seven genera are known, but these are all rather similar and have been placed in two groups, subfamilies, in a single family. The lower jaw agrees with that of the multituberculates in the absence of an angular process, but differs in the relatively long and horizontal tooth-bearing ramus and in the large and strong coronoid process. The incisors, three or four in number, are small, subequal, and simple, while the canines, absent in multituberculates, are large and laniary. The premolars are grasping or cutting teeth with a central cusp and one or two accessory cusps. The molars are rather different in detail in the upper and lower jaws and also in the various genera, but the common plan is of three main cusps in a straight longitudinal series, with cingula and cingular cusps variously developed.

Amphilestes, from the Stonesfield Middle Jurassic, appears to be the most primitive known member of the group. In it the dental formula is $I_4C_1P_4M_5$. The premolars are symmetrical with large central and small anterior and posterior accessory cusps. On the molars the central cusp is much larger than the anterior and posterior cusps. *Phascolotherium*, from the same deposit, and two surviving genera in the Morrison are similar to *Amphilestes* except in characters which are probably due to evolutionary advance. Most noteworthy are reductions in number of cheek teeth to P_4M_4, P_3M_4, or P_4M_3, asymmetrical development of the premolars, and the subequal development of the three main molar cusps, culminating in *Triconodon* itself.

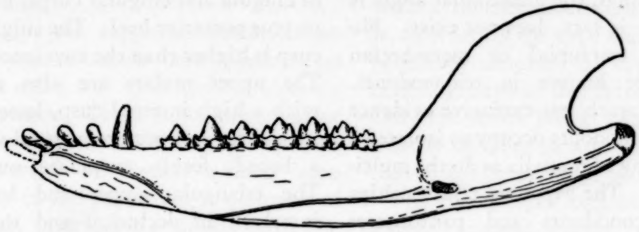


FIG. 9. PHASCOLOTHERIUM BUCKLANDI, A MIDDLE JURASSIC TRICONODONT
Internal view of right lower jaw. Two and one-half times natural size

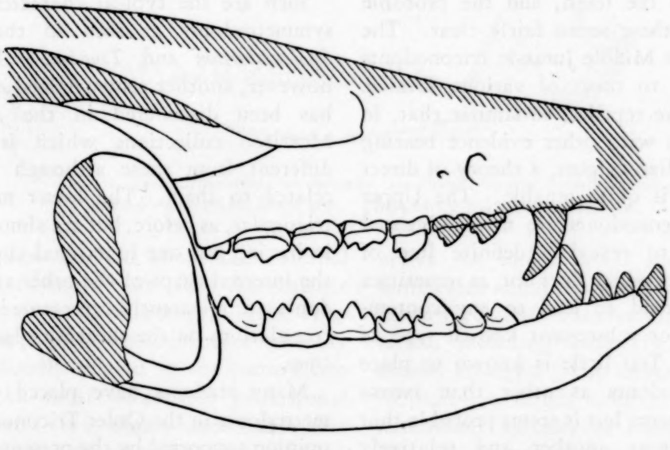


FIG. 10. PRIACODON, AN UPPER JURASSIC TRICONODONT
Composite reconstruction of part of skull and jaws, right lateral view. The cross-hatched parts are not known in this genus. Three times natural size.

The cheek dentition as a whole forms a serrated shearing edge. Upper and lower series were very strongly pressed together in occlusion by an unusual mechanical adaptation, too complex for full discussion here, and the teeth as found are usually much worn. All that is known of osteology and dentition in this group points strongly to predaceous carnivorous habits.

Unlike the case of the Multituberculata, opinion regarding the affinities of the triconodonts has been almost unanimous and has related them most closely to the marsupials. Unfortunately none of the arguments advanced in favor of this view is valid. The dental formula and tooth replacement (partly known in one form) are not marsupial, the mandibular angle is not inflected—in fact, does not exist. No distinctively marsupial or metatherian characters are known in triconodonts. So far as the much less extensive evidence goes, the triconodonts occupy as isolated a position among Mammalia as do the multituberculates. The supposed relationships between triconodonts and pantotheres also rested on faulty evidence.

Knowledge of triconodonts is largely confined to the teeth, and the probable history of these seems fairly clear. The teeth of the Middle Jurassic triconodonts are similar to those of various Triassic mammal-like reptiles, so similar that, in conjunction with other evidence bearing on mammalian origins, a theory of direct derivation is quite tenable. The Upper Jurassic triconodonts are more advanced and seem to reveal a definite line of development which does not, as sometimes supposed, tend to lead to any contemporaneous or subsequent known type of dentition. Too little is known to place the triconodonts as other than *incertæ sedis* at present, but it seems probable that they represent another and relatively short-lived independent offshoot from the basal theromorph-mammal stock.

Symmetrodonts

Least known of Jurassic orders is the Symmetrodonta, occurring only in the late Jurassic Purbeckian and Morrison. The jaw is not unlike that of the triconodonts in adaptive type. Incisors, canines, and premolars are also rather similar, being of the primitive type seen in the earlier stages of most mammalian orders, but the molars are fundamentally different. The lower molars consist essentially of three cusps disposed in a triangle and nearly symmetrical with respect to a vertical transverse plane. These teeth are complicated by the presence of cingula and cingular cusps, but there is no true posterior heel. The single external cusp is higher than the two internal cusps. The upper molars are also triangular, with a high internal cusp, lesser cusps on its antero- and posteroexternal slopes, and a broad, feebly cuspidate outer shelf. The triangular upper and lower teeth interlock in occlusion and their sharp, oblique anterior and posterior edges shear past each other.

Such are the typical characters of the symmetrodonts as seen in the genera *Spalacotherium* and *Tinodon*. Recently, however, another genus, named *Amphidon*, has been discovered in the American Morrison collections which is sharply different from these although probably related to them. The lower molars are triangular, as before, but are almost unique in having but one functional cusp, while the internal cusps of the other symmetrodonts are apparently represented by mere crenulations on the shearing edges of this cusp.

Many students have placed the symmetrodonts in the Order Triconodonta, an opinion supported by the presence of three cusps on the lower molars in each group and by the somewhat similar development of the posterior part of the lower jaw, but opposed by more numerous and apparently more important characters. The question has been influenced by the supposition that a gradation between the triconodonts and the symmetrodonts occurred. This now is found to have been due to the imperfect preservation and preparation of the available materials. The transition does not really exist, and the symmetrodonts and triconodonts are found to be very distinct. The lower molars of symmetrodonts are triangular, not anteroposterior, occlusion is that of alternating trigons, and the upper molars are so very different as to offer almost no points of comparison.

Similarly, the supposed transition between symmetrodonts and pantotheres does not exist and these groups also are quite distinct. There is, however, some basic resemblance which may prove to be an indication of distant affinity seen especially in the possession in common of triangular, interlocking molars with the main apices internal above and external below. Beyond that the resemblance does not go, and the retention of the symmetrodonts as a distinct order possibly superordinally related to the pantotheres seems the most acceptable provisional hypothesis. It is highly improbable that it represents an ancestral pantotherian structural stage, and it is not as closely related to any known later mammals as are the pantotheres.

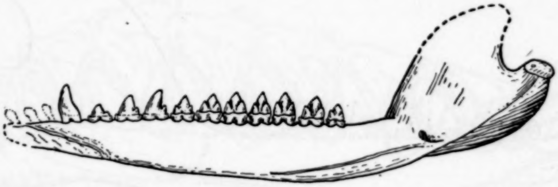


FIG. 11. SPALACOTHERIUM TRICUSPIDENS, AN UPPER JURASSIC SYMMETRODONT
Internal view of right lower jaw. Two and one-half times natural size.

Pantotheres

Among all Jurassic mammals the pantotheres (trituberculates of Osborn in a systematic, but not a morphologic sense) are most abundant in numbers and most varied in character. They also appear to be the most important for phylogenetic investigation.

Amphitherium is the only genus known from the Middle Jurassic. It is the earliest pantothere and, incidentally, was the first Mesozoic mammal to be named and made known. Its importance is very great as it is the oldest known mammal with a tuberculosectorial dentition—that is, forecasting the type almost universal in primitive members of the higher mammalian groups of the Tertiary and Recent. Only the lower jaw is known, but this is worthy of more detailed description than that of any other single genus.

The jaw itself is long and slender, with a stout coronoid process, condyle elevated above the molar level, and a distinct, uninflected angular process which projects downward and backward. The tooth series, including even the incisors, is almost straight. The dental formula is $I_4C_1P_4M_7$—a larger number than in any heterodont Tertiary or Recent mammal. The incisors are well spaced, small, subequal, slightly procumbent, and spatulate. The canine is relatively large and has two stout but closely appressed roots. The four premolars increase progressively in size and each consists of a laterally compressed main cusp followed by a small and low accessory cusp or heel. The seven molars are all of about the same size and structure, each consisting of a trigonid and a talonid as in primitive later mammals. The trigonid is composed of three cusps which do not surround a closed basin. The highest cusp (protoconid) is external, the internal and anterointernal cusps (metaconid, paraconid) subequal and connected to the external cusp, but not to each other, by sharp crests. The posterior heel, or talonid, is triangular, much smaller than the trigonid, and is not basined but slopes outward and downward. It has but one cusp, posterior in position. Each of the eleven cheek teeth is implanted by two equal roots.

So far as lower teeth are concerned. the Upper Jurassic pantotheres fall into three groups, each of which might be derived from *Amphitherium* or a similar genus. In one group, the family Paurodontidæ, the cheek teeth are generally similar to those of *Amphitherium* but much less numerous. The family includes two American genera besides the type *Paurodon*, and probably the English *Peramus* should also be placed here.

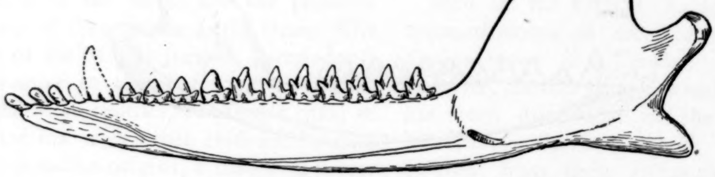


FIG. 12. AMPHITHERIUM PREVOSTII, A MIDDLE JURASSIC PANTOTHERE
Internal view of right lower jaw. Four times natural size

In the second group, family Dryolestidæ, the cheek teeth are as numerous as in *Amphitherium*, eleven or twelve in number, but the molars are more crowded, shorter anteroposteriorly, heel shorter and cusp more internal, the posterior root much smaller than the anterior and confined to the inner side of the tooth. Members of this family are numerous both in the Purbeckian and in the Morrison. Among the more important genera are *Amblotherium*, common to the two formations, the American *Dryolestes*, and the British *Phascolestes*.

The third family, Docodontidæ, is very peculiar and aberrant. Its affinities are clearly pantotherian, but the molars are much more complicated than in any other pantotheres. The lower molars have basined heels with two cusps and the trigonids have four more or less distinct cusps, while the pattern is further complicated by various cuspules, furrows, etc. *Docodon* is fairly common in the Morrison, and a single specimen referable to this family and named *Peraiocynodon* has recently been recognized in the Purbeckian.

The upper molars of pantotheres have been found in association with the lower teeth in three specimens only, all from the Purbeckian. Until recently the upper dentitions were very poorly known, but now a series of previously undescribed Morrison specimens in the Marsh Collection has been rediscovered and studied. These are not associated with lower teeth, but they are surely pantotherian and they reveal a varied series of quite peculiar dental structures. Future work on dental evolution cannot fail to take them into account. Aside from the upper molars of *Docodon*, they show certain fundamental characters, however various the details. All are triangular in outline, and most are transversely elongate. All have a prominent internal cusp and a basined crown external to this. The anterior and posterior rims of this basin may or may not bear small cuspules, and a median ridge in the basin is sometimes present. The external margin bears three cusps in all cases, and occasionally faint indications of another. Of the three, the anterior and posterior are always small, while the median one may be but little larger or may be very prominent, as large as the internal cusp. Such teeth are not like any others known and are not what might have been anticipated, but they are invaluable in giving actual Jurassic representatives of the primitive tuberculosectorial line, however aberrant some of them may eventually prove to be.

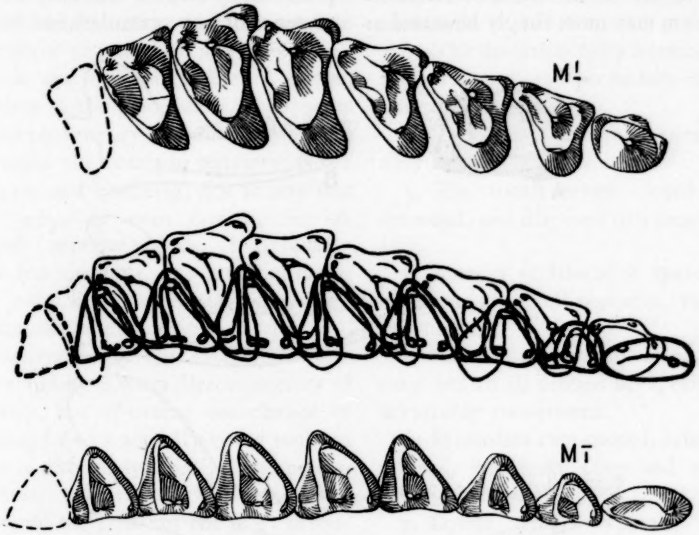


Fig. 13. Cheek Teeth and Occlusion in Upper Jurassic Pantotheres

Top, *Melanodon oweni*, right upper molars and last premolar, crown view. Bottom, *Laolestes eminens*, left lower molars and last premolar. Middle, occlusion diagram, lower teeth in heavier outline. Upper and lower teeth were not found in association and since there are several genera with about the same occlusal characters and size it is not certain that they belong together, but, for the same reasons, it is clear that this represents diagrammatically the typical occlusal relations of dryolestid pantothere teeth. About eight times natural size.

The upper teeth of *Docodon*, like the lowers, have a distinct resemblance to those of other pantotheres but are differently specialized. There is a large external cusp preceded by a cingular cusp and followed by an accessory cusp and joined by a transverse crest to the somewhat smaller internal cusp, posterior to which, in turn, there is a small accessory cuspule, the whole complicated by definite grooves and ridges on the enamel.

Multituberculates, triconodonts, and symmetrodonts are all unlike other mammals and even detailed analysis fails to connect them definitely with any later groups, but only confirms the opinion that they are very early, extinct side branches of the Mammalia. With the pantotheres the case is different, for they obviously have numerous essential, although confusing, resemblances to later mammals. Again opinion has been divided. They have been considered as related to the monotremes (Winge), to the marsupials (Cuvier, Owen), to the placentals (Marsh, 1887; Osborn), and to both marsupials and placentals (Marsh, 1880; Gregory). Winge's theory of monotreme relationships is purely theoretical and the positive evidence is strongly opposed to it. It is not now tenable. The problem may most simply be stated as follows: the dentitions of the pantotheres, while atypical in their simplicity and in some aberrant features, are clearly tuberculosectorial in general pattern as are the dentitions of most Cretaceous and Paleocene marsupials and placentals; the jaw structure and other known osteological features are also similar; the resemblance is sufficiently close to impel belief in true relationship; but it does not point clearly to any one group of later mammals, nor does it permit a ready choice between marsupial and placental affinities.

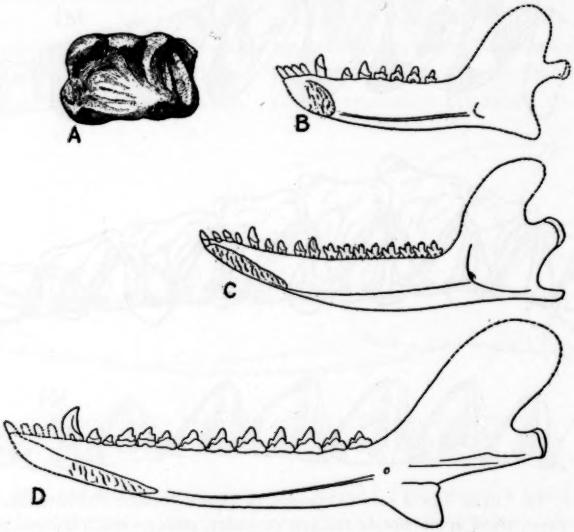


Fig. 14. Some American Upper Jurassic Pantotheres

A, *Docodon*, crown view of right lower molar. B, *Paurodon*, internal view of right lower jaw. C, *Laolestes*, internal view of right lower jaw. D, *Docodon*, internal view of right lower jaw. A, ten times natural size; others twice natural size.

Evidence of special marsupial affinities can be found only in the common presence of more than three incisors and of more than three molars, but the dental formula does not exactly agree with the marsupials in any case and the premolars are usually four in number. Valid evidence of special placental affinities is seen only in the usual presence of four premolars and in the non-inflected angular process, but again the complete dental formula is not really that of any placental. The strongest item is the non-inflected angle, but this is not invariable in placentals, occurs in one known marsupial, and is the only type known among mammal-like reptiles. It is improbable that the angular processes of marsupials and of placentals, so similar in structure and identical in function, are of independent origin. One type or the other is probably ancestral for both groups. Rather than proving placental relationships for the Pantotheria, this single character seems to support the theory, founded on other evidence, that a noninflected angle was a character of the remote therian ancestry as a whole.

Aside from this one character, and perhaps including it, the pantotheres as a group have in the known parts all the characters which must have occurred in the common ancestry of marsupials and placentals and none exclusive to either. Incomplete as the evidence is, it supports the important theory that the pantotheres do represent the common ancestry of the Metatheria and Eutheria, not in any one known genus or even family, but as structural representatives, individually more or less aberrant, of a stage of mammalian evolution before the definitive separation of these two great groups.

Amphitherium has no characters certainly excluding it from direct ancestry of later forms, but of course the chance of this isolated find's actually being such an ancestor is extremely small. The paurodonts show reduction in tooth number, even beyond the point of the most primitive placentals and marsupials, but retention of more or less *Amphitherium*-like pattern. The dryolestids retained a high number of teeth, perhaps even increasing the number slightly, but the pattern became modified chiefly by anteroposterior compression of the cheek teeth, analogous to the development of the zalambdodont insectivores in later times but quite independent and on a much more primitive basis. The docodonts were an early, one might almost say premature, attempt at molar complication which did not at all follow the analogous advances later made on the basis of a more progressive fundamental structure.

It may be interesting and even salutary to abstract the general dental characters of the primitive Theria on the hypothesis that these are structurally represented by the Pantotheria. That the results actually represent ancestral conditions is not quite certain but I believe them to be very probable and in any event they are based on facts more significant than the many highly speculative views which consider only later and relatively highly organized mammals.

1. The dentition fully heterodont, with incisors, canines, premolars and molars sharply differentiated.

2. The primitive dental formula probably $I^{4?}_{4}C^{1}_{1}P^{4}_{4}M^{7-8?}_{7-8}$.

3. The tooth series closed, but not crowded, and disposed in a nearly straight line.

4. Incisors styliform to spatulate, each with one cusp and one root, more or less procumbent.

5. Canines moderately large, with one cusp and an ill defined heel, often but not invariably two-rooted.

6. Premolars two-rooted, laterally compressed, one main cusp and a posterior heel.

7. Lower molars typically tuberculosectorial, with simple three-cusped trigonid, but with talonid relatively small, unbasined, with only one cusp; implanted by two roots.

8. Upper molars trigonal but not strictly tritubercular, somewhat elongate transversely, with a main inner cusp and a main outer cusp opposite it, the latter followed by a posteroexternal accessory cusp and preceded by a simple anteroexternal heel.

CRETACEOUS MAMMALS

The mammals of the Lower Cretaceous are almost entirely unknown. The exceptions are a few isolated teeth from the Wealden formation of England. The only one of these which is determinable, *Loxaulax valdensis*, is a close relative of *Plagiaulax* or *Ctenacodon*, a slightly more advanced plagiaulacid multituberculate.

Upper Cretaceous mammals are much better known. The first collections made were from the late Cretaceous Lance formation of Wyoming. These collections are numerically the largest, but consist mostly of isolated teeth with a very few imperfect jaws. The earlier Belly River formation of Alberta has yielded few specimens, but these include three well preserved jaws. A few other relatively unimportant discoveries have been made in North America. In South America, the lower jaw of an opossum, described by F. Ameghino under the name *Proteodidelphys*, was formerly accepted as of Cretaceous age, but it now seems almost certain that it is from the Tertiary. The recent expeditions of the American Museum of Natural History in Mongolia discovered remains of eleven individuals of Upper Cretaceous mammals in the Djadochta formation. These include skulls, jaws, and even skeletal parts and are incomparably the best known specimens of Mesozoic mammals.

Cretaceous Multituberculates

Multituberculates are relatively abundant in the Lance and contemporary formations of North America and the group is also represented by a partial skull and jaws, with associated skeletal parts, from Mongolia. All of these seem to be related to the Jurassic plagiaulacids, but they are much more advanced and have some characters which may indicate that the relationship is not directly ancestral. All are tentatively placed in the family Ptilodontidæ, based on the Paleocene *Ptilodus*. The following characters of the American forms, especially *Cimolomys* and *Meniscoëssus* give a conception of the degree and nature of the advance over the plagiaulacids:

1. Lower premolars are reduced to two, one of which is vestigial and may be lost in later (Paleocene and Eocene) genera. In the plagiaulacids they are three or four in number. The last premolar in the Cretaceous forms is relatively larger and has a greater number of serrations.

2. The first lower molar is larger than the second and has a large number of

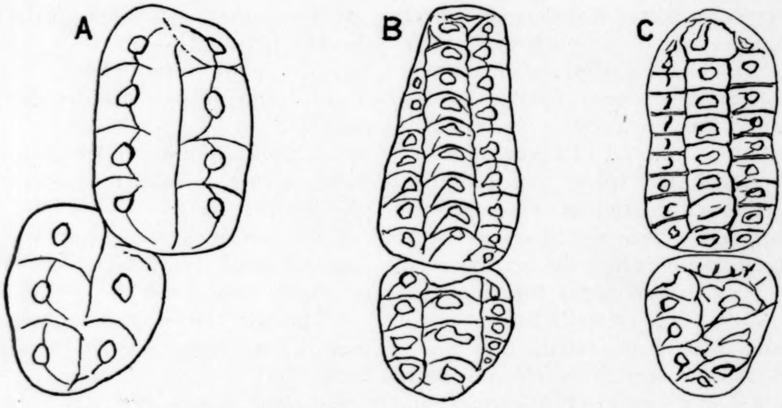


FIG. 15. UPPER MOLARS OF MULTITUBERCULATES

Crown views of the two left upper molars, anterior end up. A, *Ctenacodon*, Upper Jurassic. B, *Cimolomys*, Upper Cretaceous. C, *Taeniolabis*, Paleocene. Not to scale.

cusps. In the plagiaulacids the molars are subequal and both have few cusps.

3. There were probably only three or four upper premolars, as in Paleocene genera, although this is uncertain. There are five in plagiaulacids.

4. Only the last upper premolar is shearing in function. The last two are shearing teeth in plagiaulacids.

5. The upper molars are unequal in size, like the lowers, and they have three rows of cusps. In the plagiaulacids they are subequal and have but two rows.

6. The molar cusps are more or less crescentic and complicated by grooves and ridges. Those of the plagiaulacids are nearly conical and quite simple.

Djadochtatherium, the Mongolian genus, shares the reduction in the premolars and has various peculiar specializations, but the first lower molars appear to be almost as simple as in the Jurassic forms.

The important general facts are that multituberculates continue to form a large and important part of the mammalian fauna, that they exhibit considerable variety, but that all appear to be rather closely related to the Jurassic plagiaulacids although much more highly specialized.

Cretaceous Marsupials

None of the Jurassic mammals were referred to the Marsupialia because none were found to have definitely marsupialian, as against merely primitive, characters. In the American Upper Cretaceous not only are indubitable marsupials present, but they constitute the greater part of the fauna and are much varied in size and character. Various specimens have shown that they have not only the primitive marsupial dental formula, but also the inflected angular process, palatal vacuities, and other characteristics of the order. In most of them the teeth are strikingly like those of the recent opossums, so that they may even be placed in the same family, at least until more important differences are demonstrated.

These most opossum-like of the Cretaceous marsupials differ from the recent animals chiefly in quite minor characters, such as the equal size of the main outer cusps (paracone and metacone) of the

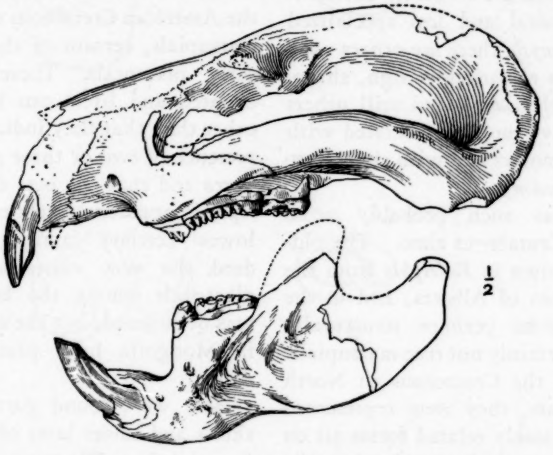


FIG. 16. TAENIOLABIS TAÖENSIS, LOWER PALEOCENE MULTITUBERCULATE
Left side view of skull and jaw. One-half natural size. (After Granger and Simpson.)

upper molars, the more uniform development and higher number (five) of the cingulum cusps or styles external to these, or the fact that the third premolar is the largest, rather than the second. One of the most remarkable facts of paleontology is the slight evolution apparently undergone by this group during the Tertiary. The recent opossum is almost a living Cretaceous mammal.

These Cretaceous opossums were, however, much more varied than are recent opossums and although many are very like the latter some are decidedly different. Besides the central and less specialized type (e.g. *Pediomys*), there are others with the molar cusps remarkably high, sharp, and piercing (*Nyssodon*), and still others with broad heavy molars associated with great blunt premolars and with short deep jaws (e.g. *Thlæodon*).

Marsupials as such probably arose during Lower Cretaceous time. The oldest actually known is *Eodelphis* from the Upper Cretaceous of Alberta, and in the Jurassic are forms perhaps structurally ancestral but certainly not true marsupials. At the end of the Cretaceous in North America, at least, they were represented by varied but closely related forms all on about the same evolutionary level as the living opossums. It is probable that the more specialized Tertiary forms of South America and recent forms of Australia were eventual products of the differentiation the beginning of which is suggested by this Cretaceous fauna. In North America itself all but the most conservative line disappeared with the great influx of placentals at the beginning of the Tertiary, but in South America the marsupials were partly and in Australia almost wholly free of placental competition, for some unknown reason.

The absence of marsupials in the Mongolian Cretaceous fauna is unexpected, but certainly does not warrant the very improbable conclusion that they were then absent in Asia. This absence of specimens may be entirely accidental, as only eleven mammalian specimens are yet known from the Cretaceous of that continent, or it may be due to the fact that the known material is from a facies unfavorable to the contemporaneous marsupials.

Cretaceous Insectivores

Although the bulk of the so-called tritubercular or tuberculosectorial teeth from the American Cretaceous clearly belong to marsupials, certain of them do represent early placentals. These are rare and isolated and little can be said of them other than that they indicate the probable presence of two or three genera of insectivores and that the best defined (*Gypsonictops*) is apparently related to the extinct lower Tertiary family Leptictidæ. Indeed the very existence of Cretaceous placentals among the known specimens was questioned, but the recent discoveries in Mongolia have placed this beyond doubt.

Here were found partial or complete skulls and lower jaws of four genera and five species. These are just as truly placental mammals as the bulk of the American Cretaceous mammals are marsupials. The dental formula and other diagnostic features of the placentals were already typically established at the time of the deposition of the Djadochta formation, approximately contemporaneous with the earliest known marsupials in North America.

The Mongolian Cretaceous insectivores fall into two groups, Deltatheridiidæ and Zalambdalestidæ, typified by the genera *Deltatheridium* and *Zalambdalestes*, which are not widely different but suggest the beginning of divergent lines.

The first family, Deltatheridiidæ, is the less specialized. The premolars and molars are sharply distinct; the upper molars have an internal cusp (protocone), two median cusps (paracone and metacone) with connate bases, and a broad outer shelf. The lower molars have rather long narrow heels, but otherwise are simply tuberculosectorial with three trigonid and three talonid cusps as in most

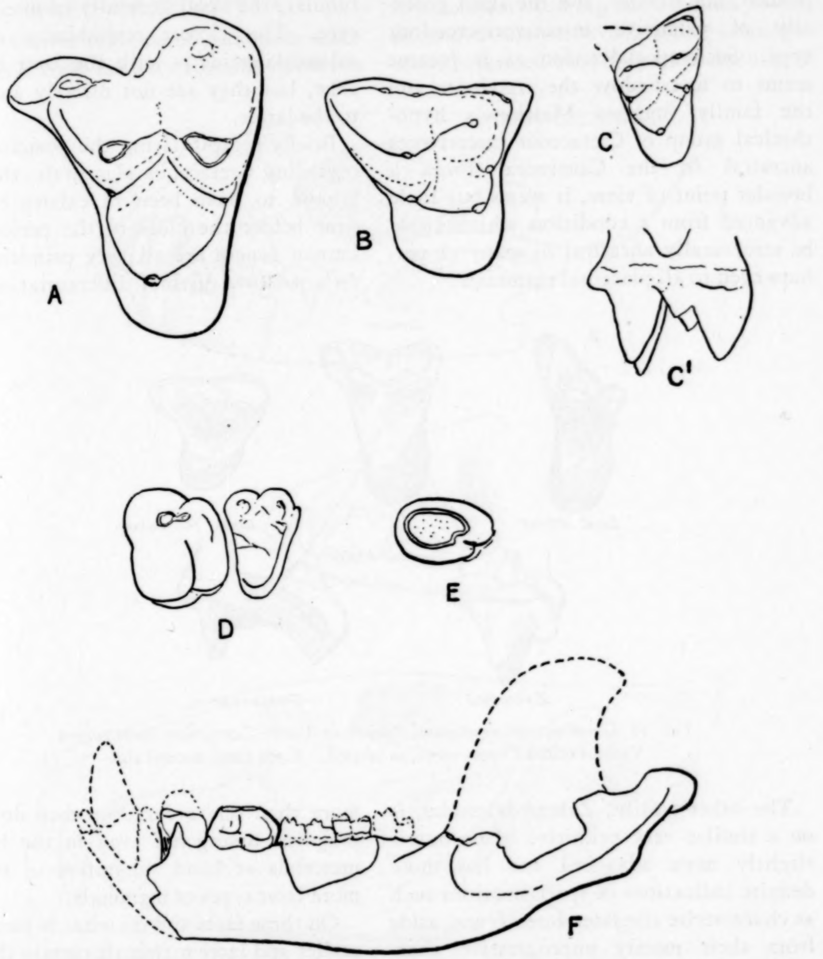


Fig. 17. Upper Cretaceous Marsupials

A, *Didelphodon*, crown view of left upper molar. B, *Pediomys*, crown view of right upper molar. C, *Nyssodon*, crown view of left upper molar. C¹, Same, posterior view. D, E, F, *Thlæodon*. D, Crown view of left last upper molar and first molar. E, Crown view of left last lower premolar. F, External view of left lower jaw. A-C, six times natural size. D-F, not to exact scale (D about two, E about one and one-half, and F about one). (D-F redrawn after Matthew.)

Paleocene mammals. The canines are rather large and laniary. The snout is fairly short, the braincase somewhat expanded, not tubular, and the skull generally of primitive insectivore-creodont type. Such specialization as is present seems to foreshadow the creodonts and the family suggests Matthew's hypothetical group of Cretaceous insectivores ancestral to the Carnivora. From a broader point of view, it seems but little advanced from a condition which could be structurally ancestral to many or perhaps even to all placental mammals.

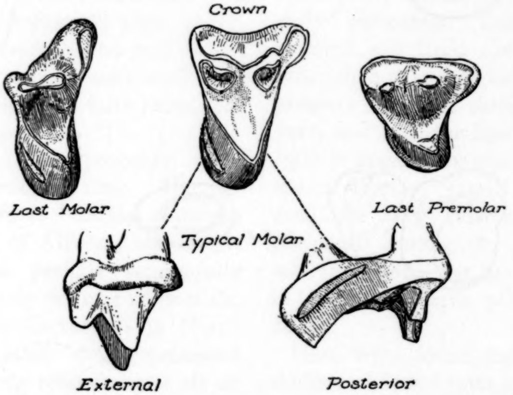


Fig. 18. Gypsonictops hypoconus, American Upper Cretaceous Insectivore
Various isolated upper teeth, as labeled. Eight times natural size

The other family, Zalambdalestidæ, is on a similar very primitive plane but is slightly more advanced and has more definite indications of specializations such as characterize the later Insectivora, aside from their merely unprogressive characters. The posterior premolars are partly molariform; the upper molars are strongly transverse, with partly connate, nearly external paracone and metacone. The lower molars are of primitive tuberculo-sectorial type, but with the trigonids somewhat compressed anteroposteriorly. The incisors are procumbent and one pair may be enlarged. The snout is long and slender, somewhat depressed anteriorly, and the braincase is rather long and tubular, the skull generally of insectivore type. The closest resemblance of the zalambdalestids is with the later Leptictidæ, but they are not directly ancestral to the latter.

Briefly recapitulating the positive facts regarding Cretaceous placentals, they are known to have been in existence some time before the close of the period, the known genera are all very primitive and do not show distinct differentiation into more than one order, but they do show incipient divergence even in the limited materials at hand suggestive of two or more later types of mammals.

On these facts and on what is known of earlier and later mammals certain theories may be based for future more definite proof or disproof: that while ordinal differentiation of the placentals was already under way in Djadochta time it was not long antecedent, that the known forms do give a conception of the structural character of placentals at that time, the other orders not being greatly different, and that placentals as such probably arose, like marsupials and from a common stock with them, in the earlier Cretaceous.

THE HISTORY OF MAMMALS

The known remains of Mesozoic mammals give clear answers to some questions regarding the long pre-Tertiary history of the class. Even when they fall far short of certainty or well founded theory, the data here sketched in brief outline are important in the negative but salutary sense of checking unreasonable speculation and of indicating those pages of mammalian history which are still blank for us. It is necessary to keep these lacunæ as well in mind as the positive facts, for it has too often happened that they have been fictitiously filled by speculation and that this speculation has passed from hand to hand until it approaches the fixity of dogma.

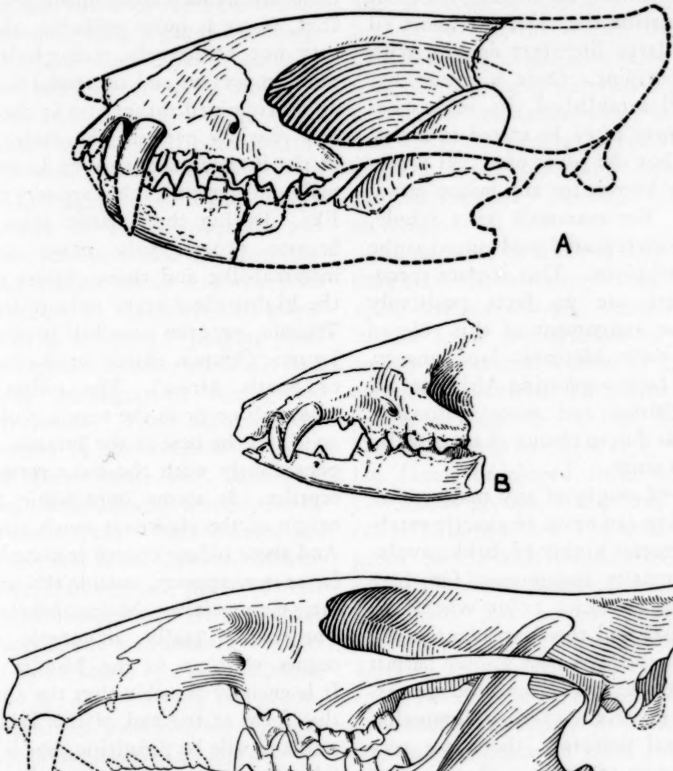


Fig. 19. Mongolian Upper Cretaceous Insectivores

Left side views of skulls and jaws. A, *Deltatheridium pretrituberculare*. B, *Hyotheridium dobsoni*. C, *Zalambdalestes lechei*. All twice natural size. (A and B after Gregory and Simpson.)

Among the points on which the known

remains of Mesozoic mammals cast no light is the geographic place of origin of mammals. Origins are inevitably obscure and, belabor them as we will, paleontological data inevitably involve a large element of chance, the chance of preservation and the chance of discovery. Without questioning its interest, one must certainly question the value of almost all of the now large literature dealing with geographic origins. Once a group has become well established, its subsequent migrations may often be traced in elaborate detail, but the place of actual origin is not surely known for any major group of animals. For mammals as a whole, Africa has been repeatedly advanced as the probable birthplace. This is pure speculation. There are no facts positively opposing the assignment of this rôle to any of the early Mesozoic land masses, and the few facts suggesting Africa are all very inconclusive and more reasonably interpreted as due to chance than as really valid in this sense.

The time of origin of any major taxonomic division can never be exactly established if, as seems highly probable, evolution is essentially continuous, for there can never be an exact point where the ancestry ceases and the descendant group begins. Yet the facts now known permit a very reasonable theory as to the approximate time of origin of the Mammalia. In the general literature, there is a very strong tendency to suppose that a given group arose in the period preceding that in which its oldest known fossils occur: the oldest mammals are Triassic, therefore the mammals are usually said probably to have arisen in the Permian. This, even though it should eventually prove to be correct, is now an example of the uncritical perpetuation of an ill considered opinion. It takes no account of the widely variant lengths of the geological periods in the more or less arbitrary scale in use, or of the exact date of the first known mammals, or of their real nature, or of much pertinent but collateral evidence. When these considerations are studied, it becomes clear that the only theory tenable on present evidence is that mammals as such arose in the Triassic and that, if, as is quite probable, the origin was not completely monophyletic, the more important and successful lines probably originated rather late in the Triassic and possibly even in the early Jurassic. In the Permian there are no known mammals and no reptiles that are very mammal-like. During the Triassic some reptiles became progressively more and more mammal-like and those closest of all to the higher class occur only in the Upper Triassic, or even possibly in the Lower Jurassic (known chiefly in the Stormberg of South Africa). The oldest known mammals occur in the very top of the Triassic and the base of the Jurassic, contemporaneously with the most mammal-like reptiles. It seems improbable that the origin of the class was much antecedent. And these oldest known mammals are, so far as now appears, outside the ancestry of later mammals, an aberrant basal offshoot. The oldest really archetypic mammal occurs well up in the Middle Jurassic. It is entirely possible that the ancestor of this form at the end of the Triassic was still a reptile by definition, but it is somewhat more probable that the ancestry ceased to be nominally reptilian during the Upper Triassic.

The remains of the earliest mammals do not cast much light on their own ancestry. They do suggest the probability that forms mammalian by definition arose from various different members of some single reptilian group. To this extent the mammals are probably polyphyletic (although this is not taken to invalidate the essential unity of the Class), but the vast majority of recent mammals, all with the possible exception of the monotremes, are of monophyletic origin in the fullest sense of the words. Approximately what that reptilian group was is known not from the actual mammalian remains but from reptilian fossils. It was almost certainly a group of therapsids and probably very close or actually belonging to the Ictidosauria of Broom.

Whenever and wherever they arose, mammals were widely distributed by the end of the Jurassic. They are known from East Africa, England, and the Rocky Mountain area in North America and although not yet discovered on other continents, had almost surely had the time and opportunity to reach all the major land areas of that period. Judging from the known representatives, mammals had then already undergone a world-wide adaptive radiation. They occupied the diverse stations of life available to land animals of their small size, including carnivorous, herbivorous, insectivorous, and omnivorous types. This mammalian radiation, the first if the dubious Rhæto-Liassic forms are excepted, involved four orders: Multituberculata, Triconodonta, Symmetrodonta, and Pantotheria. Their divergence dated from, or even preceded, the origin of the class and only one group, the less specialized pantotheres, lay near the ancestry of the marsupials and placentals. The two latter groups were apparently not yet in existence as such.

Two of these four Jurassic orders do not reappear in any form in the subsequent record. In some unknown region and during the first half of the Cretaceous, another type of mammalian fauna developed from the other two of the Jurassic orders. This included multituberculates, more progressive than but not profoundly different from those of the Jurassic, and the potentially much more important marsupials and placentals, each in their most primitive form. The marsupials of this fauna were all opossum-like and the placentals were all insectivore-like. This was certainly the Upper Cretaceous faunal type in North America, and it probably extended over a much greater part of the world, although the distributional evidence is poor and inference can only be tentative. These Upper Cretaceous mammals seem to represent a second great mammalian radiation of distinctive type, involving three orders: Multituberculata, Marsupialia, and Insectivora.

All of these Cretaceous orders survived that period, but the first two were never again dominant faunal elements, at least in the great connected land masses in which the central events of mammalian evolution occurred. In some unknown region and during the later half of the Cretaceous, a third major type of mammalian fauna developed from one of the Cretaceous groups, the primitive placentals. This new fauna was largely composed of the archaic placentals, typical of the Paleocene: condylarths, creodonts, and many less known groups. Their appearance marks the beginning of the Tertiary Period, the true Age of Mammals. They reduced the remnants of the Cretaceous mammalian radiation to relative insignificance in most parts of the earth, and they almost entirely replaced the reptiles ecologically.

Finally, at the beginning of the true Eocene came the fourth and last major mammalian radiation, that of the modernized placentals. During the Lower Eocene the multituberculates finally succumbed, after a recorded history of perhaps 90,000,000 years, and only the opossums and some insectivores retained a definite semblance to the now remote Mesozoic ancestry.

The most impressive point in this sequence of events is the way four successive waves of mammalian faunas of different type seem to have spread over the world, each wave bringing new orders of progressively higher type. Perhaps the greatest mystery in this history is where these faunas came from, and why, and how. The first two radiations are so isolated in present knowledge that it cannot be positively asserted that they did not develop more or less *in situ*, although this does seem improbable. Regarding the last two, however, so much is known that it is almost inconceivable that they can have developed from preceding faunas where they are found. It seems certain that they originated in some large but isolated area which is unknown paleontologically and that the union of that area with the known parts of the world permitted their sudden spread. Where that cradle of the higher mammals was is a question that still baffles inquiry.

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THE PREMAXILLA IN THE PRIMATES (*Concluded*)

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3. THE PREMAXILLA IN MAN

BEFORE proceeding with the record of my observations it is necessary to ask an important question, and to answer it. This question is: Knowing something of the manner of obliteration of the facial part of the premaxillary suture in man, and the relatively simple manner of obliteration of the same suture in the sub-human Primates, is it a justifiable procedure to compare the simple *datum* of obliteration of this suture in the said Primates with the same *datum* in man? In other words, since a premaxillary suture, according to the majority of our authorities, is not present or distinguishable upon the facial aspect of the skull in man after the third foetal month, owing to its being overgrown by a profusion of ossificatory material, is it a justifiable procedure to compare this manner of obliteration of the premaxillary suture with the simple interstitial manner of obliteration of the same suture in the sub-human Primates? Surely, it is obvious that such a comparison cannot justifiably be made, for we are here dealing with two characteristically different modes of ossification; in the one ossification taking place by the development of an osseous plate above the suture (where the suture exists), although without obliterating it in its greatest extent (for the suture remains widely open beneath this plate for a considerable period after its appearance in man), in the other the suture being obliterated by means of the interstitial proliferation and deposit of ossificatory material between its borders.

Partial persistence of premaxillary suture in the human foetus

How then, if at all, are these two phenomena to be compared? To this question the following considerations supply the answer. In the first place, it is necessary to inquire whether it is in fact true that the premaxillary suture is not distinguishable upon the facial aspect of the human skull after the third foetal month. Our authorities, on the whole, agree that it is not so distinguishable. The observations here recorded, however, are unequivocally positive upon this point, as a result of which it becomes possible to state that the premaxillary suture is frequently visible upon the facial aspect of the skull in man immediately up to the time of birth and in a fair number of cases up to the fifth post-natal year of age. By this I do not mean, what we already know, that the suture is present endofacially, upon the internal nasal aspect of the maxilla, but that it is in fact present upon the externum or facial aspect of the skull. Nor is it meant to convey that the suture is present in its entirety as is the case in the sub-human Primates, but that it is present upon the facial aspect only *partially*. The fact that the premaxillary suture is present at all upon the facial aspect of the human skull is for us the important point.

In the skull of a negro male foetus aged 9.27 months (No. D.A. V), before the writer at the time of writing, the only part of the premaxilla that has been overgrown by the maxillary plate is that portion of it situated immediately below the base of the pyriform aperture together with a few intermittent sections immediately lateral to its infero-lateral border; the apex of the naso-maxillary process of the premaxilla remains, however, quite free, and is separated from the maxilla by a widely open suture, (Fig. 4A). Under the microscope, at a small magnification, this suture has the appearance of a broad chasm,—immediately lateral and inferior to it a cancellous plate of maxillary ossificatory material is present, this plate having quite distinguishably overgrown the inferior portions of the premaxilla. The apical portion of the premaxillary suture, as well as the premaxilla itself, have in this specimen not yet been overgrown by this material, and, indeed, there is now available ample enough evidence to show that the maxillary plate often fails to overgrow the apical portion of the premaxilla, in such cases ossification taking place by the process of simple interstitial growth, as is normally the case in the sub-human Primates. The fact that in this specimen this suture forms the posterior border of the apical premaxilla and that it is continuous with the endofacial premaxillary suture, which runs uninterruptedly open all the way down, and transversely across to the naso-palatine foramen (Fig. 4B) whereat it becomes continuous with the palatine portion of the suture, and terminates laterally at the posterior border of the distal canine wall, proves beyond question that this is none other than the facial part of the premaxillary suture, that is, the apical portion thereof.

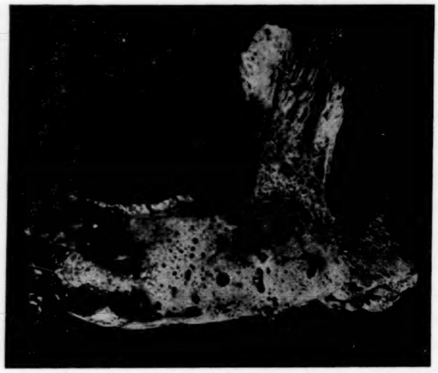


FIG. 4 A. VIEW OF THE RIGHT MAXILLA OF A MALE NEGRO FOETUS AGED 9.27 MONTHS (NO. D.A. V) DISPLAYING THE UNOBSCURED SUPERIOR OR APICAL PORTION OF THE PREMAXILLA UPON THE FACIAL ASPECT

The premaxillary suture may be seen superiorly separating the premaxilla from the maxilla.

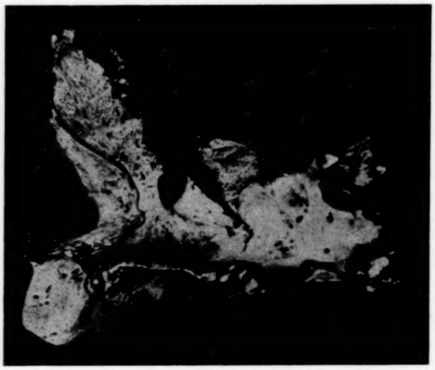


FIG. 4 B. VIEW OF THE ENDOFACIAL ASPECT OF THE BONE SEEN IN FIG. 4 A

The premaxilla and the suture separating it from the maxilla is here visible in its entirety.

Ten additional foetuses have been examined, and in order to check my observations comparatively, these have been divided into negro and white groups of practically equivalent ages, ranging from 4.58 months to 9.31 months of age. Age was determined according to the formula of Scammon and Calkins, 1929 (101).

No. D.A. IV. Male white, aged 4.58 months: The premaxilla has united with the maxilla apically both endo- and ecto-facially, yet without having been covered (apically) by the maxillary plate. Endofacially the inferior portion of the premaxillary suture is visible in its whole extent towards the naso-palatine foramen.

No. **D.A.** *134. Female negro, aged 5.02 months:* Endofacially the premaxillary suture is completely obliterated, only the endopalatine portion being at all visible. Facially the suture is likewise obliterated, but the maxillary plate leaves the apex and the lateral and anterior-inferior margins of the premaxilla, at the pyriform aperture uncovered.

No. D.A. III. Male white, aged 5.67 months: Endofacially the premaxillary suture is patent only upon the floor of the nasal fossa. The apical portion of the premaxilla seems to have been overgrown by, or become closely coalesced with, the maxilla in this specimen, so that it becomes difficult to say whether there are any remains of the premaxilla upon the facial aspect of the skull or not. At the base of the pyriform aperture the two plates of bone, the maxilla and the premaxilla, are separated by a deep cleft, so that here, at least, the infero-lateral portion of the premaxilla is facially distinguishable.

No. D.A. 121. Male negro, aged 6.29 months: Endofacially the inferior portions of the premaxillary suture are alone visible. Facially the suture is not apparent; the maxillary plate seems to have overgrown the inferior portion of the apex of the premaxilla, but has left the superior portion patent. It has also failed to overgrow the lateral pyriform portions of the premaxilla, and has, on each side, left a crescentric-shaped premaxillary gap.

No. D.A. 100. Female white, aged 6.80 months: Endofacially the inferior portions of the premaxillary suture are alone visible. Facially the premaxilla is almost completely overgrown by the maxillary plate, only the lateral portions at the pyriform aperture being still patent.

No. D.A. 140. Female negro, aged 7.57 months: Endofacially the apical portion of the premaxillary suture seems to have undergone a recent obliteration, for a hardly distinguishable suture line is still visible in that vicinity. Inferiorly the suture is perfectly patent. Facially the apical premaxilla is not distinguishable from the maxilla, but the associated evidence in this case proves quite conclusively that whilst the apical premaxillary suture has united with the ascending process of the maxilla by a process of simple interstitial growth, the maxillary plate has failed to overgrow this part of the premaxilla and has played no perceptible part in its obliteration, for the limits of the maxillary opercular plate are in this specimen exceptionally distinct. In this case the maxillary plate leaves the apical premaxilla, as well as a good part of the superior medial or lateral pyriform portion, uncovered. The remaining part of the premaxilla inferior and lateral to the infero-lateral angle of the pyriform aperture, is also, though to a lesser extent, left uncovered. The fissure between the maxillary and premaxillary plates is almost completely ossified, though the premaxilla remains quite clearly visible as an increasingly narrow septum of bone all the way down towards the infero-lateral angle of the pyriform aperture.

No. D.A. II. Female white, aged 7.62 months: Endofacially the premaxillary suture is patent all the way down to the naso-palatine foramen; there is, however, no trace of it apically. Facially the premaxilla is not distinguishable, and it would appear that the maxillary plate has overgrown it.

No. D.A. VI. Male negro, aged 8.55 months: Endofacially the apical portion of the premaxillary suture is obliterated, inferiorly the suture is perfectly patent. Facially the premaxilla has not completely united with the overlying maxillary plate, and is seen as a narrow lateral border of the pyriform aperture. The apical portion of the premaxilla has completely united with the maxilla, but it seems doubtful whether the maxilla has here actually overgrown the premaxilla, for the bone in this place is extremely thin. Immediately lateral to the infero-lateral angle of the pyriform aperture the maxillary plate and the premaxilla are seen clearly separated from one another, the interval being occupied by a mass of spongy osseous material.

No. D.A. 132. Male white, aged 8.59 months: Endofacially as well as ectofacially the premaxillary suture in this specimen is entirely obliterated. The endopalatine portion of the suture is alone visible, whilst the ectopalatine portion is scarcely distinguishable.

No. D.A. V. Male negro, aged 9.27 months: This remarkable specimen has already been described. (Figs. 4A & B). Endofacially the premaxillary suture is completely and broadly open, whilst facially, at the apex of the premaxilla a broad suture, or rather *fissure*, separates the maxilla from the premaxilla, whilst inferiorly and lateral to the pyriform aperture uncovered portions of the premaxilla are also seen.

No. D.A. 118. Female white, aged 9.31 months: Endofacially the premaxilla is completely indistinguishable, and this is true, too, facially. The endo-palatine portion of the premaxillary suture is also visible, whilst upon the oral palatine surface it can hardly be distinguished.

One of the most valuable facts brought out by the above observations is that in the negro foetus the premaxilla tends to lose its independence much later than in the white, a fact which can be significantly correlated with the more pronounced facial prognathism of the negro.

This fact and its relationship to the facial form of the negro had already been pointed out by Hamy in 1868 (44).

A summary analysis of the above observations yields the following facts:

Endofacially the premaxillary suture is present inferiorly in four out of five of our negroes, and completely present in the fifth. In the white foetuses this portion of the suture is present in only three out of our six cases.

Facially the apical and pyriform portions of the premaxilla are left exposed and uncovered by the maxillary plate in every one of our negroes.

In the white foetuses this is true in only one out of our six cases. In two other cases the premaxilla is slightly visible either at the base or at the infero-lateral border of the pyriform aperture.

The premaxilla is completely obliterated or obscured both endofacially and facially in two white foetuses.

The premaxilla is *completely* obliterated endofacially only in one white and in one negro foetus.

Facially the premaxilla is completely obliterated or obscured in one white foetus.

It would appear then, that throughout the primates, with few exceptions, the tendency is the same, the greater the degree of *prognathism* the later does the premaxillary suture tend to remain open and unobliterated.

For our immediate purpose, however, the significance of the preceding observations is that they prove, or tend to prove, that in the generality of late foetuses, at least, the premaxilla is not altogether obscured upon the facial aspect of the skull, and that occasionally a sutural separation between the premaxilla and the maxilla may be observed in the vicinity of the apical portion of the premaxilla upon the facial aspect of the skull. Evidence will shortly be adduced to show that a similar sutural separation between premaxilla and maxilla may occasionally be observed in young human crania up to the conclusion of the fifth year. If this is so then it is clear that the assertion that all traces of the facial premaxilla and its suture disappear in man by the end of the third foetal month is an assertion not in agreement with the facts.

The premaxilla in infants

The following observations with respect to the premaxillary suture were made upon human post-natal crania picked at random.

Male white, newborn: No trace of the premaxilla or its suture endofacially or facially.

Female white, newborn: Slight apical traces of the premaxillary suture present facially and endofacially. Suture patent endofacially inferiorly.

Male negro, newborn: Facially at the supero-lateral margins of the pyriform aperture the premaxilla is visible where it has been left uncovered by the maxillary plate. Endofacially the suture is visible inferiorly to the point where it disappears at the nasopalatine foramen.

Male (?) white, aged 11 months: In this case a very definite suture separates the distinctly visible premaxilla from the maxilla at the apex of the nasomaxillary process of the premaxilla. The suture, as was to be expected, is continuous with the completely patent premaxillary suture endofacially, (Fig. 5).

Female (?), aged 12 months: A slight suture is visible facially, though endofacially the suture appears to be completely obliterated.

Male (?), aged 19 months: A slight suture is visible on the right side only. Endofacially the suture is visible in its entirety on both sides of the skull.

Female white, aged 29 months: A slight suture, about 3.0 mm. in length, is present on both sides facially. Endofacially the suture is present in its entirety.

Female white, aged 5 years: No trace of the premaxilla facially. Endofacially the suture lines are still visible.

Female white, aged 5½ years: Facially very slight traces of a suture are distinguishable apically. Endofacially the suture is seen only inferiorly.

In 29 additional skulls of similar age range the premaxillary suture was not seen upon the facial aspect in a single instance, though endofacially the premaxillary suture was seen either in its whole or partial extent in 23 cases. Thus, up to the end of the fifth year the premaxillary suture was found to be partially present upon the apex of the nasomaxillary process of the premaxilla in 6 out of our 38 crania, or in 15.7 per cent of cases. This figure, to anticipate for a moment, compares interestingly with the figures found for the Anthropomorphae or great apes. In the latter traces of, as well as the completely patent, premaxillary suture were found in 52.2 per cent of cases, in the following distributions: Orang, 68.1 per cent; Chimpanzee, 15.1 per cent; and the Gorilla, 85.7 per cent. Surprisingly enough, from these figures, the conclusion is forced upon one that although the completely patent premaxillary suture is never seen upon the facial aspect of the human skull, whereas in the infant chimpanzee it is occasionally seen, *viz.* in about 3.7 per cent of cases, traces of the suture are more frequently seen in *infant-young* man than either the open or partially open suture is seen in the *infant-young* chimpanzee. The difference is only 0.6 per cent in favor of the chimpanzee, and this would serve to indicate that the rate of interstitial obliteration of the premaxillary suture in the chimpanzee is very slightly faster than the rate of apical interstitial obliteration of the same suture in man. Actually it seems doubtful whether the difference is really a significant one. The fact is, however, as many observers have already noticed, that the premaxillary suture in the chimpanzee begins to undergo obliteration in the late foetal period of development.

My own observations of the maxillary-premaxillary region made upon human foetuses prove unequivocally and conclusively that, with the exception of the anterior nasal spine and the small areas on either side of it, the premaxilla in man is not normally represented upon the anterior surface of the face below the level of the pyriform aperture. The anterior alveolar walls are *entirely* formed by, what Callender called the incisor processes of, the maxilla. Not only this, in quite late foetal crania from the sixth month to term, the incisor processes may be clearly observed to curve sharply backwards in the median plane, to form together the whole of the alveolar septum which will separate the maxillary central incisors from one another; continuing posteriorly the incisor processes come into contact with the median palatine processes of the premaxilla, at which point they again perform a curve, but this time to pass lateralwards apparently for a distance extending to about one-third of the posterior wall of the central incisor socket, to terminate in a slight tuberosity. Looking within the socket one may observe that

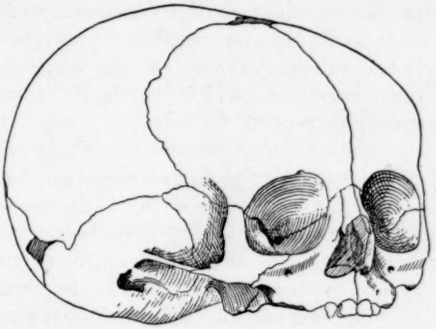


FIG. 5. INFANT WHITE SKULL AGED 11 MONTHS SHOWING THE APICAL PORTION OF THE PREMAXILLA AND ITS SUTURE FACIALLY

Upon the endofacial aspect the premaxilla and its suture are clearly visible in their entirety.

this tuberosity actually constitutes the inferior limit of an incomplete septum which lies anterior to and is separated from the posterior alveolar wall, and which together with a similar septum which originates from the posterior extremity of the lateral incisor septum (both in the fresh condition being completed by a membrane of dense white connective tissue), enclose an appreciable space which is entirely devoted to the germ of the *permanent* incisor tooth. This *transverse septum* is derived from maxilla medially, and from either the premaxilla or the maxillary incisor septum laterally. Anterior to this septum lies the developing crown of the *deciduous* central incisor, which is clearly completely surrounded by maxilla. Posterior to this transverse septum lies the germ of the developing *permanent* central incisor, which but for its anterior wall, the transverse septum, is lodged entirely within the premaxilla. With the eruption of the permanent tooth this septum becomes entirely resorbed and the tooth comes to lie in a socket which is formed anteriorly, medially, and to some extent laterally, by maxilla, and only the lateral two-thirds or three-fourths of the posterior wall of which is formed by maxilla. Anteriorly, except for the anterior nasal spine, there is no trace of the premaxilla whatsoever, it has been completely absorbed by the premaxilla, and were it not for the fact that we possess the descriptions of Nesbitt (16), Leidy (31), and Ranke (69) of foetuses between the tenth and twelfth weeks of development showing the presence of the premaxilla below the pyriform aperture separated from the maxilla by suture lines precisely as in the apes, we might well doubt the existence of the anterior wall of the premaxilla at any stage in the development of man. Actually, after the third month of development the premaxilla below the pyriform aperture completely disappears in the substance of the maxilla, and in this relation ceases to be present either as an independent lamina of bone or as a part of such. Not only does the maxilla, therefore, form the anterior wall of the incisor sockets, but it also forms the whole of the median alveolar septum which extends between the central incisor sockets and actually forms their medial walls, and in addition, forms a considerable portion, at least, of the transverse septum which separates the developing deciduous from the developing permanent central incisor. It is perfectly clear then, that in man the *anterior wall* of the premaxilla has been completely lost, appearing transitorily only between the tenth and twelfth weeks of development, whenafter it is completely absorbed and its place and function entirely assumed by the maxilla. In addition, it is to be observed that by far the largest portions of the distal septal walls of the incisor sockets are formed by the maxilla and not by the premaxilla. The posterior wall of the permanent central incisor sockets is, with the exception of the medial third which is formed by the maxilla, formed by the premaxilla, the same holds good for the lateral incisor walls, but the medial septal wall of the latter sockets are formed almost entirely by the maxilla, and this is true, too, of the canine distal septal wall. These facts are clearly shown in Figs. 6 and 7.

Thus, it is established that statements to the effect that the premaxilla lodges the incisor teeth in man, are inaccurate, for it has been shown that in man it is only the posterior portion of this bone which assists in the lodgement of these teeth, and that medially the premaxilla has been entirely replaced by the maxilla.

Upon the basis of these findings it at once becomes clear why facial premaxillary suture lines are never observed below the level of the pyriform aperture in man. The reason is simply that they have already ceased to exist by the end of the third foetal month, having been completely obliterated by proliferations of ossificatory material originating in the maxilla. The premaxilla below this level in this situation has been entirely lost in man, and has been replaced by the maxilla. Thus, man is in this respect unique, in that of all animals possessing incisor teeth he alone is the animal in which the anterior walls, which together with the posterior and lateral walls normally assist in the support of these teeth, are formed by the maxilla and not by the premaxilla as is the case in the latter. In fact, each of the four incisor sockets is, in man, almost entirely formed by the maxilla, whereas in all other animals these sockets are clearly formed entirely by the premaxilla. Thus, it becomes evident that the premaxilla has upon all sides been almost completely replaced by the maxilla, and that only an abbreviated portion of the original bone now exists in the human skull,—upon the palatine aspect orally, upon the anterior part of the floor of the nasal cavity, and upon the walls internally bordering upon the pyriform aperture laterally.

The fact that in certain forms of cleft-palate such, for example, as 'parson's nose,' a condition in which the premaxilla develops completely independently of and anterior to the maxilla, the premaxilla possesses an anterior wall behind which incisor teeth may develop, is by no means a fact incompatible with the description of the normal process of disappearance of this portion of the bone which has been given above. This and other forms of cleft-palate originate during *embryonic* development, long before the appearance of the ossificatory centers for the maxilla and premaxilla. In such abnormal cases after the appearance of the ossificatory centers each of these bones undergoes an independent development, for the most part completely separated from one another; there can thus be no possibility of the absorption of the anterior wall of the premaxilla.

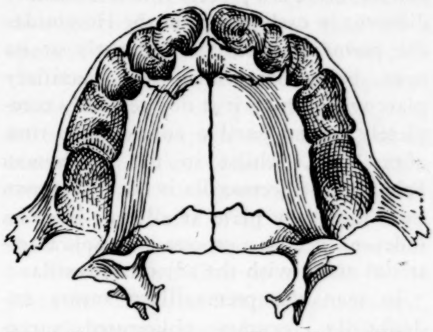


Fig. 6. Palatine View of a White Female Foetus Aged 7.62 Months (No. D.A. II) Showing the Production Posteriorly of the Incisor Processes of the Maxilla to Meet the Premaxilla, and the Beginning Development of the Distal Walls of the Incisor Sockets from the Maxilla

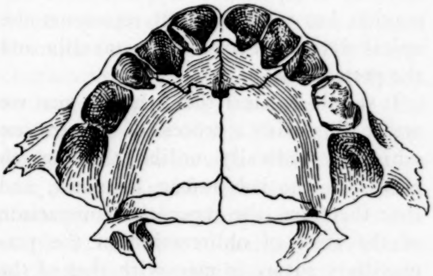


Fig. 7. Palatine View of a White Female Foetus Aged 9.91 Months (No. D.A. III) Showing the Maxillary-Premaxillary Relationships

The obliteration of the premaxillary suture in man unlike that in other Primates

With the help of these observations we are now in something of a position to return an answer to the question as to whether it is a justifiable procedure to compare the datum of obliteration of the premaxillary suture in man with the same datum in the sub-human Primates.

We have already observed that the manner of obliteration of the premaxilla and its suture is a process which is sensibly different in each group; in the Hominidae the premaxilla, except frequently at its apex, being overgrown by a maxillary plate with which it is not generally completely united until a considerable time after birth, whilst in the sub-human Primates the premaxilla is not overgrown by a maxillary plate at all, but loses its independence by a process of simple interstitial union with the adjacent maxilla.

In man the premaxillary suture undoubtedly becomes obliterated superficially beneath the maxillary plate, even though endofacially it is generally found open with free and unclosed borders until a relatively advanced age. Upon the facial aspect a remnant of the suture may be observed upon what appears to be the maxilla but which in fact represents the apical division between the maxilla and the premaxilla.

It should be clear then, that in man we are dealing with a process of obliteration which is radically unlike that which occurs in the sub-human Primates, and that therefore, the superficial comparison of the state of obliteration of the premaxillary suture in man with that of the sub-human Primates is a procedure not morphologically justifiable.

The reduction of the snout

The existence of these differences in the relations and development of the maxillary and premaxillary bones between man and the sub-human Primates leads to the question of aetiology.

A brief consideration of the form of the face in the Primates leaves little room for doubt that the chief factor instrumental in bringing about this unique change in the maxillo-premaxillary relationship in man has been the progressive and almost total reduction of the snout. The premaxilla, which in the lower mammals and Primates forms an appreciable part of the produced snout, has in man been so completely retracted that it may be said to have been almost totally embraced by the face, the maxillary bones forming a natural *operculum* over it upon every side of the pyriform aperture. Writing recently on the classification of the upper lip in mammals Boyd, 1933 (116) makes some pertinent remarks in this connection; he writes,

> The main factor in causing the relative and absolute increase in the maxillary contributions to the face would appear to be the decline in importance of the "oral sense" and the olfactory apparatus. This diminution in the importance of olfaction can be correlated with the decrease in the development of the fronto-nasal process, the maxillary processes becoming progressively more prominent in the formation of the definitive face. Another factor that may have had an influence on the process of substitution of maxillary processes for the fronto-nasal process is the marked increase in the mobility of the lips in the higher Primates.

That the mobility of the lips in the higher Primates has been a factor instrumental in the reduction of the fronto-nasal process seems open to doubt, but that a strong oral and olfactory sense is generally accompanied by a produced snout is a well established fact. The inference seems to be obvious, that with the decrease in the importance of the oral and olfactory senses, there would be, among other things, a concomitant diminution in the visceral-osseous apparatus, an important part of which is formed by the premaxilla. This diminution would express itself in a decrease in the length and size of the snout, the trend of the facial skeleton being towards orthognathism. The more the oral and olfactory senses became diminished, the smaller the relative size of the premaxilla, and the more reduced the snout would become. In addition to all this there is the important factor represented by the teeth, I mean the canine-maxillary developmental relationships. If, for example, we examine the skull of an adult Catarrhine monkey like *Papio hamadryas* in the anterior dental region, it will be observed that there exists an average diastema of some 8 mm. between the maxillary lateral incisors and the canine teeth; this diastema exists for the reception of the sabre-like mandibular canine, and is almost entirely formed by the premaxilla. In the gibbons an even larger diastema exists to accommodate the large sabre-like mandibular canine. In the orang, in which the canines are relatively reduced, a smaller diastema exists between these teeth. In the chimpanzee in which the canines are still further reduced a still smaller diastema exists. In the gorilla in which the mandibular canine in the male is extremely large and tusk-like, and appreciably larger than in the female, the diastema is relatively large, and below, in the mandible, there is an equivalent diastema. With the reduction of the canines, such as has taken place in man, such a diastema would no longer serve any useful purpose, and would therefore undergo a complete reduction, which in actuality takes the form of a reduction of the postero-lateral region of the premaxilla which in the sub-human Primates provides the structural basis for the diastema. In this manner we may account for the disappearance of the postero-lateral portions of the premaxilla in man.

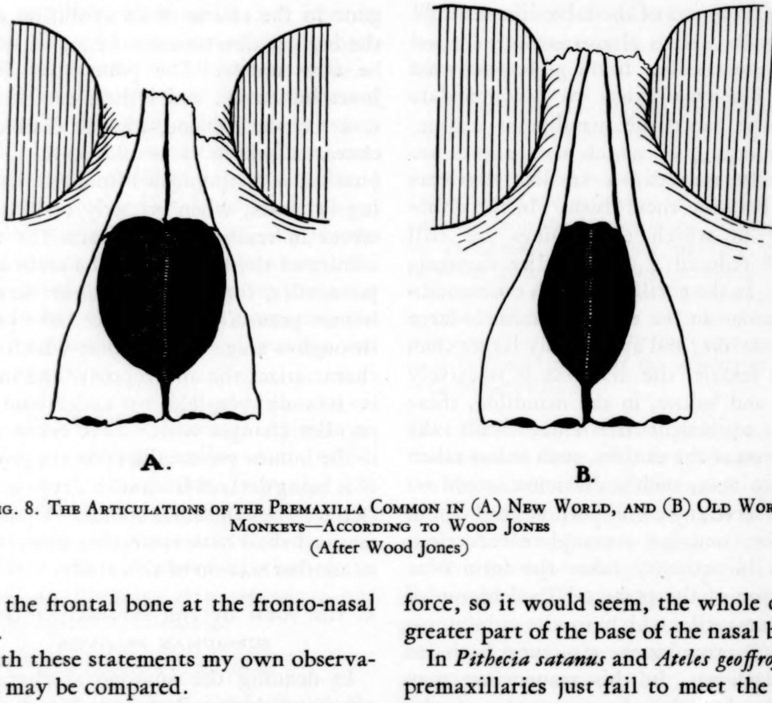
That this account of the factors which have been responsible for the reduction of the premaxilla in man corresponds, at least, to the facts, the available evidence seems strongly to attest. In the light of these facts the comparatively great differences in the size, form, and relations of the premaxilla which exist among the Primates, are easily understood.

When then, Wood Jones claims that the "Obliteration of the facial premaxilla is a distinguishing character of man as a species"; and that "it would be used by the systematist as a specific diagnostic feature of *Homo*," the point, I think, may be freely granted, for man alone, of all mammals, is characterized by the peculiar *curtaining* which his premaxilla has undergone in the course of an evolution upon the highest developmental rung of which he now stands. The point that Wood Jones has made, and is here established, is a retro-active one, for the distinctive character which it would serve to emphasize, as distinguished from the remaining Primates, when properly understood, serves in reality to emphasize the close affinity of the hominid to the anthropoid premaxilla, for it is quite clear that the human premaxilla must once have passed through a stage such as that which now characterizes the anthropoids, and indeed it is only possible to understand the peculiar changes which have taken place in the human premaxilla upon the grounds of it being derived from such a type as now characterizes the anthropoids. Upon this matter I shall have something more to say in another section of this study.

4. THE FORM OF THE PREMAXILLA IN THE SUB-HUMAN PRIMATES

In defining the anatomical characters of the Cebidae Professor Wood Jones states with respect to the premaxilla that it "either fails to meet, just meets, or slightly overlaps the lower margin of the nasal in the margin of the narial aperture" (100, p. 200). In the succeeding chapter of the same work (Chap. 28, p. 217) in listing the differences between the

Catarrhinae and the Platyrrhinae he states that in the Catarrhinae, "The premaxilla extends far up the side of the narial opening and may reach to and articulate with the frontal." In one of his figures (see Fig. 8) he illustrates what he considers to be "the articulations common in (A) the New World, and (B) Old World Monkeys;" in the first (A), the premaxilla articulates narrowly with the base of the nasal bones, and in the second (B), the premaxilla articulates rather less narrowly with the frontal bone at the fronto-nasal level.



A. B.

Fig. 8. The Articulations of the Premaxilla Common in (A) New World, and (B) Old World Monkeys—According to Wood Jones
(After Wood Jones)

With these statements my own observations may be compared.

Lemuroidea. In the Lemuroidea the short premaxillaries articulate narrowly with the infero-lateral borders of the nasal bones.

Callitrichidae. In the Callitrichidae the short premaxillaries are of two varieties, in the one the premaxilla articulates narrowly with the infero-lateral borders of the nasal bones, and in the other the premaxillaries are very slightly inserted between the infero-lateral angles of the nasal bones and the maxilla; the latter appears to be the more usual condition and does not seem to be confined to any one particular genus or species.

Cebidae. Among the Cebidae the relations of the premaxilla are variable.

In *Pithecia pithecia* and in *Lagothrix* the premaxillaries turn at right angles across the apex of the pyriform aperture to reinforce, so it would seem, the whole or the greater part of the base of the nasal bones.

In *Pithecia satanus* and *Ateles geoffroyi* the premaxillaries just fail to meet the nasal bones.

In all species of *Cebus* the premaxillaries articulate narrowly at the supero-lateral angles of the pyriform aperture with the nasal bones.

In *Ateles palliata* and *Ateles ater* the premaxillaries articulate moderately broadly with the nasal bones infero-laterally.

In *Alouatta macconelli* the premaxillaries articulate moderately broadly, and in the remaining species narrowly, with the nasal bones infero-laterally.

With respect to *Lagothrix* Wood Jones takes objection to Forbes' 1894 (65) statement that "In regard to the skeleton, the skull of *Lagothrix*, as Dr. Slack points out, can be readily distinguished from that of the Capuchins by a broad, well-marked, articulation taking place between the premaxillary and the nasal bones at right-angles to the suture between the latter, while in the Capuchins no true articulation takes place between the bones." Wood Jones (100, p. 191) objects that "this is no distinction from *Cebus*, in which the same condition is present." In point of fact, however, there *is* here present a distinction between *Lagothrix* (together with *Pithecia pithecia*) and *Cebus*, for in the former genus the nasal portions of the premaxilla are quite broad, and often articulate with one another at the base of the nasal bones. In *Cebus*, on the other hand, the articulation with the nasal bones is narrow and the premaxillaries in this genus never approximate one another at the base of the nasal bones.

Thus, upon the basis of these observations, it may be said that in the Cebidae the relations of the premaxillary bones to the nasal bones vary in different genera and even between the species of the same genus. Thus, in *Pithecia satanus* and *Ateles geoffroyi* the premaxillaries just fail to meet the nasal bones, whilst in all species of *Cebus* and the majority of Alouattinae the premaxillaries articulate narrowly with them. In *Ateles palliata* and *ater*, and in *Alouatta macconelli* the articulation is moderately broad, whilst in *Lagothrix* and *Pithecia pithecia* the articulation is very broad.

The naso-maxillary bone

We may now turn to a consideration of the nasal relations in the Lasiopygidae, or as Wood Jones prefers to call this division of the primates, the Cynomorph Catarrhines. Wood Jones, as we have already seen, considers the common form of the premaxillary articulation in this Family to be with the frontal bone at and immediately lateral to the fronto-nasal junction. In a few genera of Old World Monkeys this seems to be the case, for example, in *Pithecus barbei* and in *Pygathrix germaini*, in the *adult* forms of which the premaxilla appears to establish a clear contact with the frontal as is the case in many lower mammals, or perhaps it may be more correct to say, as *appears* to be the case in lower mammals. For the examination of any infant Lasiopygid skull reveals the fact that what in adult specimens appears to be the elongated ascending process of the premaxilla establishing a clear contact with the frontal bone is in reality a distinct and independent bone only contiguously related to the premaxilla but not part of it. In adult specimens this bone becomes indistinguishably united to the ascending process of the premaxilla, its sutural junction with the latter being completely obliterated, so that in the adult it gives the appearance of being the continued projection of the ascending process of the premaxilla. Since this bone does not appear to have been described hitherto, and since it was consistently found in all young Lasiopygid crania examined, a description of it is here given from the skull in which it was first observed.

Erythrocebus whitei, ♀ *A.M.N.H., No. 34710. Locality: British East Africa, Nasin Gishu, 7,200'. Third African Expedition—Rainsford. Oct. 26th, 1912.*

Young female in which the deciduous dentition is alone present. All cranial sutures (with the exception of the frontal) are patent.

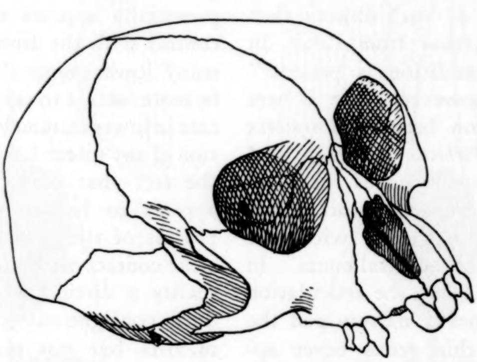


Fig. 9. Erythrocebus whitei, Infant, A.M.N.H. No. 34710 Showing the Naso-maxillary Bone Situated between the Nasal Bone and the Frontal Process of the Maxilla

The premaxillary bones are seen as two distinct wedge-shaped bi-laterally symmetrical structures situated in the median plane between the palatine alveolar and facial portions of the maxillary bones. Each premaxilla consists of a body, which is situated facially subjacent and immediately lateral to the pyriform aperture, and two processes, a palatine and a naso-maxillary or ascending process, which arise at right angles to one another from the body. The body is seen upon the facial aspect delimited from the maxilla by a suture which upon the palatine aspect arises from or is continuous with the exomesognathic division of the premaxillary suture, and proceeding laterally and slightly posteriorly, until it reaches to within the antero-lingual border of the canine alveolar ridge, passes between the lateral incisor and close to the canine alveolar septum, thus emerging upon the facial aspect whereon it continues superiorly and medially to meet the naso-maxillary suture lateral to and slightly above the bridge or base of the nasal bones as the *pars facialis* of the premaxillary suture. Within the nasal fossa the *endofacial* portion of the premaxillary suture, which is continuous with the exomesognathic portion of the premaxillary suture at the mid-lateral margin of the anterior naso-palatine foramen, proceeds superiorly upwards to the lateral angle at the bridge of the nose to meet the facial division of the suture. That part of the premaxilla adjacent to the nasal bones and representing the superior third of the premaxilla is the apical, ascending, or *naso-maxillary process* of the premaxilla. As will be seen from Fig. 9 the apex of the naso-maxillary process is for a short distance wedged between the infero-lateral border of the nasal bone and the medial border of the maxillary frontal process. Immediately above the apex of the naso-maxillary process of the premaxillary bone and articulating with it closely, as well as with the frontal process of the maxilla laterally, and with the nasal bone medially for about three-fourths of its length, is situated a narrow, somewhat fusiform-shaped bone maintaining a perfectly independent existence.

The bone above described was found to be present in all the infant and most of the young Lasiopygid crania examined, and was occasionally observed in the crania of mature individuals. This bone, which for want of a better name, we shall call the *naso-maxillary bone*, unites first with the apex of the naso-maxillary process of the premaxilla; the obliteration of the suture between it and the latter process in an adult skull would lead the observer unacquainted with the condition in the infant skull to assume that the elongate process which he observes to be continuous with the premaxilla actually represents the naso-maxillary process of the premaxilla. This is perhaps a pardonable error, but the fact is clearly otherwise. The naso-maxillary bone undoubtedly arises from a distinct ossification center of its own and in origin probably bears a close relation to the maxilla rather than to the premaxillary bone. It is not impossible that this bone represents the last vestige of one of the elements of the primitive vertebrate skull, but what this element may be it is at this stage unnecessary to venture a guess.

It is evident then, that the elongate naso-maxillary process which Wood Jones describes as commonly articulating with the frontal bone at the level of the fronto-maxillary junction in Old World Monkeys is actually an independent element contiguously associated with the premaxilla, but in origin not part of it.

Thinking that the presence of the naso-maxillary bone in the Lasiopygidae might possibly represent a new development, since it was not found among Primates lower than the Lasiopygidae, appearing for the first time in the Old World Monkeys, an examination of a new series of 42 infant crania of anthropoids was made, but in no case was any evidence of such an element found. In two young gorilla and three young chimpanzee crania, an element of similar form and lying in the same relationship as the bone in the Lasiopygidae was found in each case on both sides of the skull. A much larger number of anthropoid skulls than we have in this connection been able to report upon will have to be examined, however, before it will be possible to say with what degree of frequency this element occurs in the anthropoid skull, for that it occurs in the anthropoid skull seems more than probable. Following the anthropoid crania, infant human crania were next examined, and interestingly enough the very first skull examined, a newborn of undetermined sex and race, showed a distinct small bone at each of the supero-lateral angles of the pyriform aperture situated between the maxilla and the infero-lateral angle of the nasal bone (See Fig. 10). In the very next skull examined, that of an infant Australian aboriginal of unknown sex and aged about 7 months, two such bones were similarly found to be present. The bone is relatively about one-third the length of the

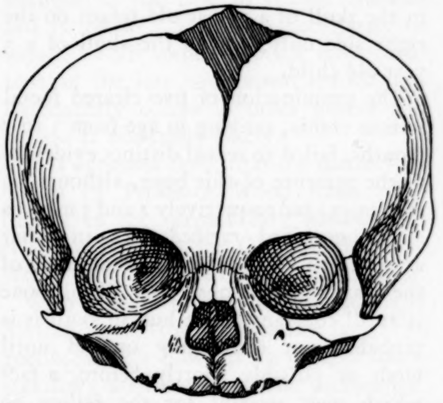


Fig. 10. Newborn Human Skull Showing the Presence of the Naso-maxillary Bone on Either Side of the Superior Lateral Angles of the Pyriform Aperture

naso-maxillary bone as it is represented in the Lasiopygidae and is relatively somewhat broader than in the latter family, but it, too, as in the Lasiopygidae tends to taper towards its extremities. It is difficult to resist the conclusion that this bone is none other than the homologue of that found among the Lasiopygidae.

In 21 additional white crania ranging in age between birth and 5 years of age, the naso-maxillary bone, or traces of it, was found in four cases, as follows: In a newborn; in the skull of a 4 months old infant; in the skull of a 3 year old infant on the right side only; and in the skull of a 5 year old child.

The examination of five cleared foetal human crania, ranging in age from 3 to 7 months, failed to reveal distinct evidences of the presence of this bone, although in two cases aged respectively 4 and 5 months a circumscribed rarified area in what appeared to be the infero-lateral angle of the nasal bone was observed. If this bone is at all constant in the human skull it is probably not completely ossified until birth or possibly shortly before, a fact which may account for the failure to observe it in these specimens; however, it is quite possible that the bone, vestigial as it undoubtedly is, only makes its appearance occasionally in man. It seems unnecessary to add that there is no legitimate reason to assume that the element here described is either an adventitious or a wormian bone.

The premaxilla in other Primates

We may now proceed with the description of the form of the premaxilla in the remaining Primates.

The terms used in the following summary description of the premaxillary, nasal, maxillary, and frontal, relations are to be interpreted as follows:

Short: The premaxillaries are short and do not reach the nasal bones.

Nasal: The premaxillaries just meet the infero-lateral margins of the nasal bones.

Slight Naso-Max: The premaxilla is inserted very slightly between the infero-lateral angle of the nasal bone and the maxilla.

Medium Naso-Max: The naso-maxillary process is inserted between the nasal bone and the maxilla for a distance about half way between the base of the nasal bones and the fronto-maxillary suture.

Long Naso-Max: The naso-maxillary process (apparently, but undoubtedly *not*, the premaxilla) which is inserted between the nasal bone and the maxilla just fails to meet the frontal bone at the fronto-maxillary suture.

Frontal: The naso-maxillary process, inserted between the nasal and maxillary bones, establishes contact with the frontal bone at the fronto-maxillary suture.

Naso-Max Bone: Naso-maxillary bone present.

An average of 65 skulls were examined for each species here noted. Unless otherwise stated all skulls belong to the *mature-adult* age group.

Papio papio, Slight Naso-Max.
Papio porcarius, Slight Naso-Max.
Papio hamadryas, Slight Naso-Max.
Papio cynocephalus, Slight Naso-Max.
Papio nigeriae, Slight Naso-Max.
Theropithecus obscurus, Short. Nasal.
Cynopithecus niger, Long Naso-Max.
Pithecus rhesus, Nasal.
Pithecus nemestrinus, Nasal.
Pithecus brevicauda, Nasal.
Pithecus thibetanum, Nasal.
Pithecus cynomolgus, Medium Naso-Max.
Pithecus fascicularis, Medium Naso-Max.
Pithecus sinicius, Medium Naso-Max.
Pithecus mulatta, Slight, and Long Naso-Max.
Pithecus barbei, Frontal.
Lasiopyga diana (Infant), Naso-Max. Bone. Slight Naso-Max.
Lasiopyga diana, Long Naso-Max.

Lasiopyga nicticans, Medium Naso-Max.
Lasiopyga stuhlmani, Medium Naso-Max.
Lasiopyga callitrichus, Slights, and Long Naso-Max.
Lasiopyga cephus, Slights, and Long Naso-Max.
Lasiopyga denti, Medium and Long Naso-Max.
Lasiopyga petaurista, Medium, and Long Naso-Max.
Lasiopyga campbelli, Long Naso-Max.
Lasiopyga mona, Long Naso-Max.
Lasiopyga kolbi, Long Naso-Max.
Erythrocebus whitei (Infant), Naso-Max. Bone. Slight Naso-Max.
Erythrocebus whitei, Long Naso-Max.
Erythrocebus patas, Long Naso-Max.
Erythrocebus albigenis, Long Naso-Max, and Nasal.
Pygathrix johnii, Slight, and Medium Naso-Max.
Pygathrix germaini, Frontal.
Cercocebus atterinus, Nasal Nasal.
Cercocebus agilis, Slight Naso-Max.
Cercocebus ituricus, Medium Naso-Max.
Colobus cottoni (Infant), Naso-Max. Bone. Slight Naso-Max.
Colobus cottoni, Slight Naso-Max.
Colobus brunneus (Infant), Naso-Max. Bone. Slight Naso-Max.
Colobus brunneus, Slight, and Long Naso-Max.
Colobus satanus (Infant), Naso-Max. Bone. Slight Naso-Max.
Colobus satanus, Long Naso-Max.
Colobus caudatus, Slight Naso-Max.
Colobus verus, Slight Naso-Max.
Colobus tephrosceles, Long Naso-Max.

In the baboons of the genus *Papio* a naso-maxillary bone was not encountered once. In this genus the nasal bones are extremely narrow, so that if a naso-maxillary bone is present among them, which is doubtful, it is probably extremely rudimentary.

From our findings for the infant and adult members of *Lasiopyga diana*, *Erythrocebus whitei*, *Colobus satanus*, and *C. cottoni*, it should be quite clear that the ascending process of the premaxilla generally articulates but slightly with the nasal and maxillary bones, being inserted between them for but a short distance. The naso-maxillary bone, as a rule, unites with the ascending process of the premaxilla early in adult life, thus producing the appearance of a prolonged ascending process of the premaxilla, the prolongation having in reality an origin quite independent of the premaxilla. Thus, when properly analysed, it transpires that the frontal and nasal relations of the premaxilla in the Lasiopygidae are substantially the same as in other Primates.

It is also of interest to note that whilst the naso-maxillary bone generally unites with the ascending process of the premaxilla, it also unites laterally quite frequently with the maxilla alone, as for example is the case in *Colobus brunneus* and *C. cottoni*. That this peculiarity of union, which seems to occur most regularly in the last two named species, not infrequently occurs in other genera and species is extremely likely.

It is apparent then, that the distinction drawn by Professor Wood Jones with respect to the premaxillary naso-frontal relations between the Old and the New World Monkeys, is excusably inaccurate.

With respect to the anthropoids, the African apes, the chimpanzee and the gorilla show a constant very slight naso-maxillary articulation of the premaxilla. Possibly the articulation is established by means of an attached naso-maxillary bone, but of this we have no actual evidence. In the Asiatic apes, the gibbon and the orang-outan, the articulation is variable, in some specimens the premaxilla just failing to meet the nasal bones whilst in others it establishes a slight contact with them.

In the human specimens showing the presence of the naso-maxillary bone, the premaxilla does not articulate with the nasal bone. Where a naso-maxillary bone was not observed as such the premaxilla establishes a very slight naso-maxillary contact.

In the constancy and form of the premaxillary-nasal relations the resemblance

GENUS	INFANT												YOUNG											
	Male						Female						Male						Female				
	No.	P	T	O	V	Per-cent O	No.	P	T	O	V	Per-cent O	No.	P	T	O	V	Per-cent O	No.	P	T	O	V
Lemur	6	6	—	—	—	0.0	1	1	—	—	—	0.0	42	39	3	—	—	0.0	24	23	—	1	—
Callithrix	1	1	—	—	—	0.0	1	1	—	—	—	0.0	8	8	—	—	—	0.0	9	8	1	—	—
Midas	1	1	—	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—
Callicebus	3	2	—	1	—	33.3	2	2	—	—	—	0.0	1	1	—	—	—	0.0	7	0	—	7	—
Aotus	1	1	—	—	—	0.0	3	3	—	—	—	0.0	2	2	—	—	—	0.0	7	6	1	—	—
Pithecia	5	5	—	—	—	0.0	7	7	—	—	—	0.0	4	4	—	—	—	0.0	4	4	—	—	—
Samiri	6	2	—	4	—	66.6	11	8	—	3	—	27.2	12	4	2	6	—	50.0	19	7	2	10	—
Alouatta	10	10	—	—	—	0.0	18	18	—	—	—	0.0	17	17	—	—	—	0.0	18	18	—	—	—
Ateleus	11	9	1	1	—	9.9	7	6	—	1	—	14.3	7	7	—	—	—	0.0	10	10	—	—	—
Brachyteleus	1	1	—	—	—	0.0	1	1	—	—	—	0.0	1	1	—	—	—	0.0	2	2	—	—	—
Lagothrix	3	3	—	—	—	0.0	5	5	—	—	—	0.0	2	2	—	—	—	0.0	—	—	—	—	—
Cebus	18	14	2	2	—	11.1	13	11	1	1	—	8.4	34	14	4	16	—	47.0	40	16	4	20	—
Colobus	24	24	—	—	—	0.0	19	19	—	—	—	0.0	13	12	—	1	—	7.7	23	22	—	1	—
Nasalis	3	3	—	—	—	0.0	7	7	—	—	—	0.0	2	2	—	—	—	0.0	4	4	—	—	—
Pygathrix	10	10	—	—	—	0.0	37	37	—	—	—	0.0	11	11	—	—	—	0.0	31	30	—	1	—
Erythrocebus	115	113	2	—	—	0.0	106	103	1	2	—	1.9	41	39	1	1	—	2.4	84	75	5	4	—
Lasiopygia	68	67	1	—	—	0.0	78	76	1	1	—	1.3	61	59	2	—	—	0.0	70	68	1	1	—
Cercocebus	8	8	—	—	—	0.0	10	10	—	—	—	0.0	11	11	—	—	—	0.0	5	5	—	—	—
Pithecus	115	113	2	—	—	0.0	106	103	1	2	—	1.9	41	39	1	1	—	2.4	84	75	5	4	—
Theropithecus	2	2	—	—	—	0.0	2	2	—	—	—	0.0	4	4	—	—	—	0.0	—	—	—	—	—
Cynopithecus	—	—	—	—	—	—	7	7	—	—	—	0.0	2	2	—	—	—	0.0	3	3	—	—	—
Papio	14	14	—	—	—	0.0	10	10	—	—	—	0.0	34	34	—	—	—	0.0	45	45	—	—	—
Symphalangus	3	3	—	—	—	0.0	—	—	—	—	—	—	—	—	—	—	—	—	3	2	1	—	—
Hylobates	17	8	8	1	—	5.8	14	9	4	1	—	7.1	10	4	2	4	—	40.0	4	3	—	1	—
Orang	22	19	1	2	—	9.1	22	16	4	2	—	9.1	13	8	2	3	—	23.1	8	4	2	2	—
Chimpanzee	38	3	8	27	—	71.0	43	—	6	37	—	86.0	35	—	4	31	—	88.5	36	—	2	34	
Gorilla	14	9	3	2	—	14.3	18	11	3	3	+RTL 1	16.6	26	22	1	3	—	11.5	41	35	2	4	—
	406	340	26	40	—	9.8	436	364	20	51	1	11.7	405	318	22	65	—	16.0	502	395	21	86	—

between the African apes and man is singularly striking.

5. THE OBLITERATION OF THE MAXILLO-PREMAXILLARY SUTURE IN THE PRIMATES

In Table 1 will be found the particulars with respect to the degree of obliteration of the premaxillary suture in 5,277 sub-human Primates arranged according to genus, age, and sex. The terms and symbols used in this Table have the following meaning:

Infant: Skulls in which the deciduous dentition is either partially or completely erupted, but in which no permanent tooth has erupted.

TA E I

maxillar ure in the Primates

MATURE											ADULT												TOTAL NO.	TOTAL O	TOTAL PER CENT O
Male					Female						Male						Female								
P	T	O	V	Per-cent O	No.	P	T	O	V	Per-cent O	No.	P	T	O	V	Per-cent O	No.	P	T	O	V	Per-cent O			
11	—	3	—	21.4	17	14	—	3	—	17.6	19	4	2	12	−R+L 1	63.1	13	1	—	12	—	92.3	136	31	22.7
7	1	1	—	11.1	7	7	—	—	—	0.0	2	2	—	—	—	0.0	7	6	1	—	—	0.0	44	1	2.3
2	—	—	—	0.0	2	2	—	—	—	0.0	4	4	—	—	—	0.0	1	1	—	—	—	0.0	11	0	0.0
17	—	—	—	0.0	26	0	1	25	—	95.1	14	—	—	14	—	100.0	25	—	—	25	—	100.0	95	72	68.5
9	2	2	—	15.3	26	19	2	5	—	19.2	19	1	2	15	−R+L 1	78.9	25	3	4	16	—	69.6	94	38	40.4
22	1	—	—	0.0	13	9	3	1	—	7.7	42	25	10	7	—	16.6	24	18	4	2	—	8.3	122	9	13.6
2	3	53	−R+L 2	88.3	54	2	2	50	—	92.5	38	—	—	37	−LTR 1	97.3	13	—	—	13	—	100.0	213	176	83.1
30	4	3	—	8.1	39	23	1	15	—	8.1	91	17	6	68	—	74.7	91	7	6	78	—	85.7	321	164	51.0
11	3	—	—	0.0	22	19	3	—	—	0.0	32	3	3	26	—	81.2	30	2	2	26	—	86.6	133	52	39.1
1	1	—	—	0.0	3	2	1	—	—	0.0	3	1	2	—	—	0.0	5	1	1	3	—	60.0	18	3	16.6
8	4	—	—	0.0	9	6	2	1	—	11.1	18	8	3	6	+L−R 1	33.3	9	3	1	5	—	55.5	58	12	20.6
6	2	40	+R−L 1	81.6	60	4	1	55	—	91.6	88	1	—	87	—	98 7	61	—	1	60	—	98.3	363	281	77.4
12	—	—	—	0.0	24	20	2	2	—	8.3	155	86	27	42	—	27.1	89	57	17	14	+RTL 1	15.7	359	60	16.7
1	1	1	—	33.3	9	7	2	—	—	0.0	10	2	2	6	—	60.0	2	1	—	1	—	50.0	40	8	20.0
24	7	3	—	8.8	67	60	4	3	—	4.4	101	12	13	76	—	75.2	75	24	16	35	—	46.6	366	118	32.9
14	3	1	—	5.5	48	37	5	6	—	12.5	97	51	15	30	1	30.9	30	14	6	10	—	33.3	539	54	10.1
97	3	2	—	1.9	77	69	7	—	+L−R 1	0.0	201	133	41	27	—	2.3	68	55	7	6	—	8.8	725	37	5.1
16	1	—	—	0.0	19	17	2	—	—	0.0	35	21	9	5	—	14.2	23	21	1	1	—	4.3	128	6	4 6
14	3	1	—	5.5	48	37	5	6	—	12.5	97	51	15	30	+L−R 1	30.9	30	14	6	10	—	33.3	539	54	10 1
6	—	1	—	14.3	2	2	—	—	—	0.0	6	3	2	1	—	16.6	1	1	—	—	—	0.0	24	2	9 5
1	—	—	—	0.0	2	2	—	—	—	0.0	6	5	1	—	—	0.0	—	—	—	—	—	—	18	0	0.0
18	1	1	TL−R 1	4.8	32	31	1	—	—	0.0	82	62	11	9	—	1.9	53	44	6	3	—	5.6	291	17	5.8
2	1	—	—	0.0	—	—	—	—	—	—	12	—	—	12	—	100.0	4	—	—	4	—	100.0	25	16	64.0
1	—	12	—	92.2	2	—	—	2	—	100.0	49	1	—	48	—	98.0	32	2	—	30	—	93.7	141	99	70.2
2	—	5	—	71.4	12	1	1	10	—	83.3	70	—	4	66	—	94.3	26	1	2	22	+R−L 1	86.3	180	112	62.2
-	—	9	—	100.0	11	—	—	11	—	100.0	78	—	—	78	—	100.0	108	—	—	108	—	100.0	358	335	93.5
20	3	5	—	17.8	37	14	6	17	—	46.0	197	6	42	146	+L−R +R−L 3	74.1	86	3	13	67	+RTL +R−L 3	77.9	447	247	55.2
341	41	143	4	27.0	621	368	46	206	1	33.2	1477	456	195	818	8	55.3	901	267	88	541	5	59.0	5277	1851	35.2

Young: In which the third permanent molar is unerupted, and the basilar suture is open.

Mature: In which the complete permanent dentition is present and in an unworn condition, and the basilar suture is closed.

Adult: In which the dentition shows an appreciable amount of wear, and beginning sutural union is present in two or more cranial sutures.

No.: Number of skulls examined.

P.: Premaxillary suture present in its entire extent.

T.: Premaxillary suture partially obliterated, traces present.

O.: Premaxillary suture completely obliterated in its entire extent.

V.: Variant forms of obliteration.

Per Cent O.: Percentage of skulls in which the premaxillary suture is completely obliterated.

+R-L.: Premaxillary suture present on right, obliterated on left side.

+L-R.: Premaxillary suture present on left, obliterated on right side.

TR-L.: Traces of premaxillary suture on right, obliterated on left side.

TL-R.: Traces of premaxillary suture on left, obliterated on right side.

+RTL.: Premaxillary suture present on right, traces only on left side.

All percentages refer to complete obliterations of the premaxillary suture. Skulls in which *traces* of the suture were present are recorded separately.

It should be noted here that all skulls displaying signs of an advanced age, more particularly as exhibited in the general obliteration of the cranial sutures, were excluded from the series recorded in Table 1 as tending to give a false weight to the percentage of obliteration of the premaxillary suture in the adult group.

Lemuroidea

In the Lemuroidea it appears that the premaxillary suture begins to show signs of obliteration as early as the period of youth. In 7.1 per cent of young males the suture was found to be in various stages of obliteration, whilst in 4.1 per cent of females the suture was completely obliterated. Following the period of youth the suture undergoes a progressive obliteration until, in the female adult 92.3 per cent of crania show a complete absence of any trace of the suture. Thus, 22.7 per cent of the total number of Lemurs examined showed complete obliteration of the premaxillary suture.

Callitrichidae

In the Callitrichidae a mature skull of *Callithrix* showed complete obliteration of the suture, that is, 11.1 per cent of mature males, or 2.3 per cent of the total number examined (44 crania).

Eleven skulls of *Midas* were examined and these all showed the unobliterated suture.

In *Callicebus*, which may be regarded in this as in other respects as the most advanced of the Callitrichidae, a surprisingly high percentage of crania show complete obliteration of the premaxillary suture, viz. in 33.3 per cent of infant males, 100.0 per cent of young females, 95.1 per cent of mature females, and in 100.0 per cent of mature adults. Total obliterations, 68.5 per cent.

TABLE 2

The Obliteration of the Premaxillary Suture in the Primates

FAMILY	NO. EXAMINED	OBLITERATED IN	PERCENT OBLITERATED IN
Lemuroidea	136	31	22.7
Callitrichidae	150	73	48.6
Cebidae	1322	735	55.6
Lasiopygidae	2518	203	7.6
Hylobatidae	166	115	69.3
Anthropomorphae	985	694	70.4
	5277	1851	35.2

Of all Callitrichidae examined 48.6 per cent showed complete obliteration of the premaxillary suture.

Cebidae

In the Cebidae the premaxillary suture tends to become obliterated fairly early in post-natal development, thus, 12.7 per cent of male and 7.7 per cent of female infants of this family exhibit the suture completely obliterated.

Aotus shows beginning obliteration first in a young female, or in 11.1 per cent of young, when after there is a gradual increase in the frequency of obliterations until 73.8 per cent of adults show complete obliteration of the suture. The total obliterations were 40.4 per cent.

In *Pithecia* partial obliteration is found first in about 11.1 per cent of mature individuals, and complete obliteration in only 2.8 per cent of the same group. Adults showed complete obliteration in 10.3 per cent of cases only, males showing exactly twice as many obliterations as females. The suture was thus found obliterated in a total of 13.6 per cent of cases.

In *Saimiri* the premaxillary suture was found completely obliterated in 41.2 per cent of infants, in the proportions of 66.6 per cent of males and 27.2 per cent of females. This represents a somewhat remarkable finding for a Cebid monkey, since with the exception of the chimpanzee (70.9 per cent of obliterations in the infant) no other sub-human primate exhibits anything approaching as high a frequency of obliteration of this suture in infancy, unless it be *Callicebus* with 33.3 per cent of infant obliterations (3 cases examined only). The tendency toward obliteration of the premaxillary suture is maintained and markedly displayed in the older series, adults showing a frequency of obliteration of 98.0 per cent. Of all Saimiridae 83.1 per cent show complete obliteration of the suture, a percentage that is exceeded only by the chimpanzee with 93.5 per cent.

In *Alouatta* partial and complete obliteration is first observed in the mature group, 23.7 per cent of the mature crania showing complete obliteration, the females with 35.8 per cent showing four times as many obliterations as the males with 8.1 per cent. The adults show a fairly high proportion of obliterations, viz. 80.2 per cent, the females with 85.7 per cent showing a slightly higher percentage than the males with 74.7 per cent. The total number of obliterations in the Alouattinae was 51.0 per cent.

In *Ateles* the somewhat bewildering observation that 11.1 per cent of infants exhibit complete obliteration of the premaxillary suture whilst no other age group up to the adult displays a similar condition must be accounted merely one of the vagaries of the quantitative method of investigation, particularly since the number of cases examined in each age group was by no means as exhaustive as one could have wished (total 133). *Partial* obliteration occurs in an infant male, or in 9.9 per cent of infants, and subsequently is again observed in 16.6 per cent of mature cases, whilst 83.3 per cent of adults show complete obliteration, the females with 86.6 per cent slightly predominating over the males with 81.2 per cent. A total of 39.1 per cent of Atelinae show complete obliteration of the premaxillary suture.

Only 18 skulls of *Brachyteleus* were examined. Beginning obliteration is first observed in 40.0 per cent of mature crania, and complete obliteration in 60.0 per cent of adult females. Of the total number 16.6 per cent thus show complete obliteration. These figures are probably not strictly reliable owing to the small number of Brachytelid skulls examined. In *Lagothrix* the infant and young skulls showed the suture perfectly patent. In the mature group 30.0 per cent of the males and 22.2 per cent of the females show *partial* obliteration, whilst only the females show complete obliteration in 11.1 per cent of cases. Of adults 40.7 per cent show complete obliteration. In *Lagothrix* a total of 20.6 per cent of cases show complete obliteration of the premaxillary suture.

Cebus shows a relatively high proportion of complete obliterations for all ages, thus, 9.7 per cent of infants, 48.6 per cent of young, 87.0 per cent of mature, and 98.6 per cent of adults,—a total of 77.4 per cent showing complete obliteration of the premaxillary suture.

For the Cebidae as a whole then, 735 skulls out of a total of 1322, or 55.6 per cent show complete obliteration of the premaxillary suture.

Lasiopygidae

The Lasiopygidae exhibit a quite surprisingly small number of obliterations of the premaxillary suture, showing a frequency of only 7.6 per cent of obliterations, which is by far the lowest for all the Primates examined, and is exactly two-thirds lower than the frequency for the Lemuroidea, which we found to be 22.7 per cent. With the exception of *Colobus* with 16.7 per cent, *Nasalis* with 20.0 per cent, and *Pygathrix* with 32.9 per cent of obliterations, the remaining seven genera of Lasiopygidae examined show a frequency of obliteration never exceeding 10.1 per cent. Now, it is an interesting fact that the three genera just named all belong to the Semnopitheque division of the Lasiopygidae, a group which is separated by numerous characters from the remaining Lasiopygidae here considered, namely, the Cercopithicinae. This observation offers a possible clue to the determination of the probable factor responsible for the more frequent obliteration of the premaxillary suture in certain genera and not in others. This clue is suggested by the fact that the Semnopitheques in question exhibit a total of 24.3 per cent of obliterations, whilst the Cercopitheques exhibit only 6.6 per cent of obliterations, a frequency three-fourths less than that of the Semnopitheques. Now, the Semnopitheques possess very short muzzles, whereas the Cercopitheques possess muzzles which are generally elongate, in the Cynomorphae being very produced; these facts may point to a significant correlation between the form of the muzzle and the frequency of obliteration of the premaxillary suture. The detailed analysis of these characters in the Lasiopygidae yields the following results:

Very Short Muzzle:

	Per Cent of Obliterations
Colobus	16.7
Nasalis	20.0
Pygathrix	32.9
Average	24.3

Slightly Elongate Muzzle:

	Per Cent of Obliterations
Cercocebus	4.6
Lasiopyga	5.1
Pithecus	10.1
Average	6.9

Moderately Elongate Muzzle:

	Per Cent of Obliterations
Erythrocebus	3.5
Theropithecus	9.5
Average	5.7

Very Elongate Muzzle:

	Per Cent of Obliterations
Cynopithecus	0.0
Papio	5.8
Average	5.5

From these figures it would seem that there is in general a slight tendency for long-muzzled forms to display a greater frequency of unobliterated premaxillary sutures than in the shorter muzzled forms. The significant fact is, however, that all the Cercopitheques have more or less produced muzzles, whereas none of the remainder of the Primates here considered, with the exception of the lemurs, possess such prolonged muzzles. The comparatively high frequency of obliterations in the lemurs, 22.7 per cent, is explained by the fact that the lemur skull undergoes a very early general synostosis which causes its sutures, with one or two exceptions, to disappear quite early in post-natal development. From all this there can be little doubt that the premaxillary suture tends to persist in long-muzzled Primates; and from our other observations, in association with this last, we may, I think justifiably, draw the general inference that the premaxillary suture tends to undergo a more frequent obliteration with the progressive reduction of the snout.

Anthropoids

The anthropoids exhibit a variably high frequency of obliterations of the premaxillary suture.

Only 25 skulls of *Symphalangus* were examined, 64.0 per cent of which showed complete obliteration of the premaxillary suture.

Of *Hylobates* 141 skulls were examined, and of these 70.2 per cent showed complete obliteration of the premaxillary suture, as follows: 7.4 per cent of infants, 35.7 per cent of young, 93.3 per cent of mature, and 96.3 per cent of adults. Similar figures would probably have been obtained for *Symphalangus* had an equal number of skulls been examined.

The orang shows 62.2 per cent of complete obliterations, as follows: 9.1 per cent of infants, 23.8 per cent of young, 79.0 per cent of mature, and 91.6 per cent of adults.

The chimpanzee shows the highest frequency of obliterations of any of the anthropoids or any of the Primates with the exception of man, namely, 93.5 per cent of complete obliterations. In my series of chimpanzees the premaxillary suture is completely obliterated in 79.0 per cent of infants, within which group are included seven newborn skulls of which two showed complete obliteration of the suture, that is, 28.6 per cent of newborns. The suture is completely obliterated in 91.5 per cent of young, and in 100.0 per cent, respectively, of mature and adult individuals, (See fig. 11).

The gorilla, curiously enough, shows the lowest frequency of obliterations, namely, 55.2 per cent, distributed as follows: Infant, 15.6 per cent; young, 10.4 per cent; mature, 33.8 per cent; and adult, 75.2 per cent. The drop from 15.6 per cent of obliterations in the infant to 10.4 per cent in the young must be considered as due once more to the vagaries of the inadequate simple quantitative method of evaluating results.

The three great apes show, altogether, a total frequency of obliterations of 70.4 per cent.

Summarised the detailed results for the frequency of obliteration of the premaxillary suture in the anthropoids are as follows:

	Gibbon	*Orang*	*Chimpanzee*	*Gorilla*
Infant.......	7.4	9.1	79.0	15.6
Young......	35.7	23.8	91.5	10.4
Mature......	93.3	79.0	100.0	33.8
Adult.......	96.3	91.6	100.0	75.2
Total......	70.2	62.2	93.5	55.2

In Fig. 11 these results are graphically expressed. It will be observed that in the chimpanzee by the period of youth the premaxillary suture is almost invariably obliterated, only 21.0 per cent of infant and 8.5 per cent of young showing the presence of the suture. No other anthropoid shows anything approaching so high a frequency of obliteration either in infancy or youth, whilst for the mature group only the gibbon approaches the chimpanzee with 93.3 per cent of complete obliterations, the next in order being the orang with 79.0 per cent.

Why the premaxillary suture should tend to persist latest in the gorilla, which is the least prognathous of the apes, I am at a loss to understand, unless the explanation be found in the heavy development of the anterior teeth, which are quite obviously subject to far heavier stresses than is the case in the other apes.

In the primates as a whole it would appear that there is a slight sexual variation in favor of the female for the premaxillary suture to undergo obliteration earlier and somewhat more frequently than in the male.

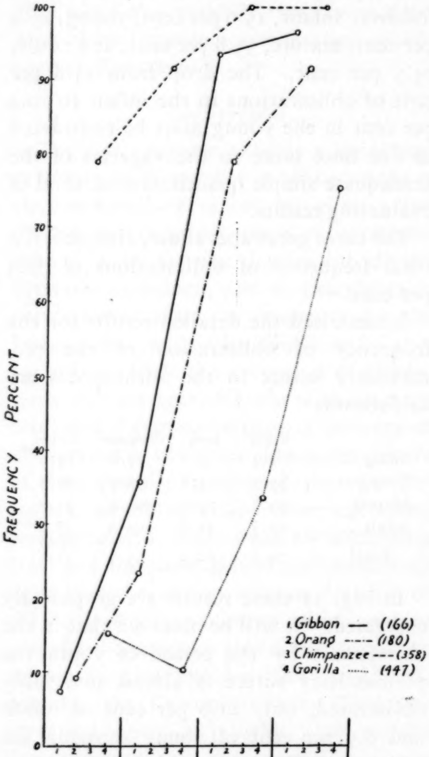


FIG. 11. GRAPH SHOWING THE FREQUENCY OF OBLITERATION OF THE PREMAXILLARY SUTURE IN THE ANTHROPOIDS

As for the manner of obliteration, this is always interstitial and invariably proceeds from below upwards, commencing first at the antero-inferior alveolar margin and proceeding upwards until the apical portion of the premaxillary suture is finally obliterated.

Man

With respect to the post-natal human material hereunder referred to, 4,632 skulls ranging between the ages of 6 to 60 years were examined, comprising altogether some 42 of the races of mankind. In not one of these skulls was the slightest trace of a premaxillary suture found upon the face, though endofacially the suture was seen in about 25.0 per cent of cases. We have already seen that traces of the suture may sometimes be found at the inferior naso-maxillary junction, upon the face, up to the end of the fifth year; thereafter, it appears, not the slightest trace of a suture is to be observed.

From what we know of the premaxillary naso-maxillary relations upon the facial aspect of the skull, and the peculiarities of development in this region, it seems certain that in a large proportion of the lower races of mankind and in a fair number of Caucasian crania, the premaxilla remains unobscured upon the face towards its junction with the infero-lateral border of the naso-maxillary bone, or if the existence of the naso-maxillary bone is doubtful, with the infero-lateral border of the nasal bone. The independence of the premaxilla here is, of course, lost, but that a small apical area of it remains unobscured upon the face in a large number of crania seems to me rendered certain by my observations upon the development of this region in foetal and infant human crania. Certain it is, too, that in almost all human crania the supero-lateral borders of the pyriform aperture are formed by the premaxillary bones alone.

6. CONCLUSIONS

The purpose of this study has now been achieved. The form, structure, and relations of the premaxilla in the Primates have been described, and the peculiar form and structure of the human premaxilla, here for the first time clearly demonstrated, accounted for. It has been shown that the form of the premaxilla in man is due to a perfectly comprehensible structural adaptation which has of necessity followed upon the extreme reduction in the importance of the oral, olfactory, and dental functions, which has found expression in the associated reduction of the oral-olfactory-dental apparatus in man,—in the great shrinkage of the premaxilla anteriorly, a shrinkage which may be said to have completely reduced the anterior projection of the face. We have seen that the sub-pyriform facial portion of the body of the premaxilla has, in man, completely disappeared and been replaced by the maxilla, which now contributes the greater part of the bony support for the four maxillary incisors. The central incisors are the first teeth to erupt in the upper jaw; the site of their development must therefore be early completed, and the whole region in which they develop early stabilized, and this we find to be the case. In development therefore, the process of embracement of the premaxilla by the maxilla commences first inferiorly and terminates finally upon the naso-maxillary process. It has been shown, however, that the terminal embracement of the premaxilla is often incomplete, as may be determined by the careful examination of the apical portion of the naso-maxillary process of the premaxilla in newborn and occasionally, in infant human crania. Often a suture between the maxilla and the apical premaxilla may be clearly observed upon the facial aspect of such skulls; if this suture is carefully examined it is seen to be none other than the facial portion of the premaxillary suture, proving that even upon the facial aspect of the human skull all anthropoid traits with respect to the premaxilla are not yet fully obliterated.

In such races of mankind in which the projection of the jaws is still somewhat pronounced (exemplified in this study by the negro), the premaxilla appears to be somewhat larger than in the more orthognathous races, and tends to undergo obliteration appreciably later. This fact is in complete harmony with the finding that in the sub-human Primates, with one or two exceptions, the premaxillary suture invariably undergoes obliteration much earlier in life in the shorter-muzzled than in the longer-muzzled forms, thus, for example, the Cynomorphae or dog-faced baboons exhibit a significantly far smaller number of obliterations of this suture than do the shorter-muzzled Cebidae. Likewise, negro foetuses show the premaxillary suture more frequently patent apically and endofacially than do white foetuses of similar age.

Without entering further upon the reasons, we may say then, that in general the smaller the size of the premaxilla, the sooner is its union with the maxilla effected. In man, in whom this bone is relatively smaller than it is in any other animal, the union commences, though it is not completed until long after, at a very early period, at about the end of the third foetal month. It would appear then, that early maxillary-premaxillary union is correlated with the size of the premaxilla. This does not necessarily mean that the size of the premaxilla determines the period at which the latter's independence is lost, but, rather as is more likely, that these two factors are together determined by a series of others, such as the size of the anterior teeth, and the degree of development of the oral-olfactory senses. In this connection it is important to note that the period at which the size of the premaxilla was acquired in the evolutionary development of any particular Primate is of no consequence whatsoever; whether early or late in the phylogenetic development of the species, the period in the ontogenetic development of the individual at which the union of the premaxilla with the maxilla takes place is dependent entirely on what Wood Jones has dismissed as certain "grounds of expediency in development," and these have already been stated above.

Surely, in view of the facts which have here been brought to light, it is quite unnecessary, not to say undesirable, to make an appeal to the so-called Biogenic Law, as Wood Jones does, in order to explain in man the early commencement of the "merging" of the premaxilla in the maxilla? It is difficult to see how matters could be otherwise if by "merging" we understand more correctly "enclosure" or "embracement," for the premaxilla preserves a great part of its structural independence from the maxilla until well after birth, so that there is here actually no question of merging, but, instead, merely a matter of masking, which is a very different thing. The reasons for this have already been stated. It is in this peculiar masking of the premaxilla by the maxilla in man that a feature of specific value may be recognised, and with these modifications the recognition of it is entirely due to Professor Wood Jones.

The alleged differences between the Old and the New World Monkeys with respect to the frontal relations of the premaxilla have been shown to be nonexistent, but to be due rather to the presence of an interpolated element occurring in the skull of all Old World Monkeys; this bone has been called the *naso-maxillary bone*, and has been shown to be only *contiguously* related to the premaxilla, being in origin in no way part of it. The homologous element has also been demonstrated for a few cases in man, and possibly the chimpanzee and the gorilla; its presence in all African ape and human crania is doubtful, and it is perhaps better to assume for the time being that this element is only occasionally present in these groups.

The strong retrogressive trend of the premaxilla in man is reflected in the great frequency with which it is disordered. Cleft-palate and hare-lip, complete or partial absence of the incisor teeth, especially of the lateral incisors, supernumerary teeth, eversion of the canine with contact of the lateral incisors and the first premolar, twisted and tilted incisors, decrease in the breadth of the nose, with crowding of the nasal septum, decrease in the inter-orbital breadth, and shortening of the upper lip, these are some of the better-known conditions which may be regarded as due to this retrogressive trend affecting the premaxilla.

Congenital absence and reduction of the lateral incisors occurs among a few subhuman Primates (117, 118), but with nothing like the frequency with which it occurs in man in whom it is to be regarded as the result of the fact that the region in which these teeth normally develop, namely, the postero-lateral portions of the premaxilla, represent areas of great instability in consequence of their intensive reduction.

7. SUMMARY

1. The purpose of this study has been to determine whether or not the alleged early obliteration of the facial division

between the maxillary and premaxillary bones, in man, may be regarded as a definite human specific character. The detailed anatomy of the human premaxilla is reserved for a future study.

2. The form, structure, and relations of the premaxilla, and the period of obliteration of the facial portion of the premaxillary suture in man and the subhuman Primates have been examined and determined in approximately 10,000 crania including some 42 of the less frequently reported upon races of mankind.

3. It has been shown that the form of the premaxilla in man at the end of the third foetal month is almost identical in form with that of the anthropoids; that, immediately after the end of the third foetal month the anterior wall of the body of the premaxilla becomes overgrown by the lateral plates of the maxilla, and is, with the exception of the anterior nasal spine and the inferior portions of the pyriform aperture, completely absorbed and replaced by them. It is in this peculiar process of obliteration of the facial portion of the premaxilla in man that a character of a specific nature may alone be recognised.

4. The peculiar involution of the premaxilla in man is shown to be a necessary adaptation following upon the extreme reduction of the olfactory and oral senses, in association with the great reduction in the size of the anterior teeth.

5. It has been shown that the apical portion of the premaxilla may be observed upon the facial aspect of the late foetal and infant human skull in a fair proportion of cases quite clearly separated from the maxilla by a distinct suture. In skulls exceeding six years of age the suture is never to be observed facially, though it may be seen endofacially, to a greater or less extent, in some 26 per cent of cases.

6. It has been shown that in the Primates as a whole the period at which the premaxillary suture tends to undergo obliteration is correlated with the size of the premaxilla; the smaller the size of the premaxilla the earlier does the suture tend to undergo obliteration. Thus, negro foetuses, which are distinctly more prognathic than white foetuses, show a strong tendency for the remains of the premaxillary suture to remain unobliterated for a greater period of time than in the more orthognathous white foetuses. The early union of the maxilla with the premaxilla is in no way connected with the period in the phylogenetic history of the species during which the peculiar characters of the premaxilla were acquired, but is the expression, rather, of early functional demands.

7. The naso-maxillary relations of the premaxilla are described, and it has been shown that they are substantially the same in all Primates, including man.

8. A hitherto unrecognised, but constantly found, bone situated at the apex of the ascending or naso-maxillary process of the premaxilla, between the nasal bone medially and the frontal process of the maxilla laterally, in infant-young Old World monkeys is described as the *naso-maxillary bone*. Ignorance of the existence of this bone has led to the inaccurate description of the frontal relations of the premaxilla in Old World monkeys. This bone is also described in a few young human crania. It is considered to be the vestigial homologue of the similar element in Old World monkeys. It was not found in anthropoids, though it may be present in them.

9. A review of the literature dealing with the premaxilla is provided.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will frequently appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to Dr. Raymond Pearl, Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *1901 East Madison Street, Baltimore, Maryland, U. S. A.*

EXPERIMENTAL EVOLUTION

Being a review of *The Struggle for Existence* by G. F. Gause. Baltimore (The Williams & Wilkins Co.), 1934. Pp. ix + 163. 9 x 6 inches. $3.00.

By Thomas Park, Department of Biology, School of Hygiene and Public Health, The Johns Hopkins University.

Much has been said about the struggle for existence and its rôle in evolution; in fact, Charles Darwin wrote a book on the subject in 1859. However, up until the last fifteen years little of real advance has been contributed towards the problem since Darwin's writings. These pertinent facts are pointed out in the foreword to Gause's book by Raymond Pearl, pioneer of the modern population school, who says:

> At the present time there is abundant evidence of an altered attitude; and particularly among the younger generation of biologists. The problem (i.e., the struggle for existence) is being attacked, frontally, vigorously and intelligently. This renewed and effective activity seems to be due primarily to two things: first, the recrudescence of general interest in the problems of population, with the accompanying recognition that population problems are basically biological problems, and, second, the realization that the struggle for existence and natural selection are matters concerning the *dynamics of populations*, birth rates, death rates, interaction of mixed populations, etc.

As can be seen from the foregoing, Doctor Gause studies the struggle for existence by combining the technique of the experimental population student with that of the mathematician and statistician. The book is organized around six chapters: Chapter I, "The problem"; Chapter II, "The struggle for existence in natural conditions"; Chapter III, "The struggle for existence from the point of view of the mathematicians"; Chapter IV, "On the mechanism of competition in yeast cells"; Chapter V, "Competition for common food in protozoa," and Chapter VI, "The destruction of one species by another."

In Chapter I the author outlines the problem and its attack as he sees it. Simply put, the procedure consists in setting up and reviewing experiments with relatively simple organisms which are in some form of competition or "struggle" either with themselves, their food supply, or with other species occupying a similar ecological niche. To these actual experimental data are applied certain mathematical constants, to be mentioned later, which tend to place the results on a comparable basis relative to competition and to give a quantitative expression of the intensity of the struggle for existence. Yeast cells and various species of protozoa are the organisms from which the deductions are drawn. The author's opinion as to the relative value of mathematics and biology in attacking this problem can best be stated in his own words:

> There is no doubt that the struggle for existence is a biological problem, and that it ought to be solved by experimentation and not at the desk of a mathematician. But in order to penetrate deeper into the nature of these phenomena we must combine the experimental method with the mathematical theory, a possibility which has been created by the brilliant researches of Lotka and Volterra. This combination of the experimental method with the quantitative theory is in general one of the most powerful tools in the hands of contemporary science.

In the second chapter, Doctor Gause reviews some of the features of the struggle for existence as it has been observed in nature. It is pointed out, and pertinently so, that plant and animal communities, although frequently possessing a definite ecological structure, are typically too complex in their structure and function to permit of many simple deductions relative to competition. It is possible, however, to get a not-too-complex conception of the struggle for existence in nature by witnessing competition, both interspecific and intraspecific, between certain organisms of relatively simple plant and animal communities. In summarizing this phase of the problem Gause says:

> . . . . let us note the following picture of the struggle for existence in nature. It is only in the domain of botany that these processes are coming to be investigated from a certain general viewpoint as (1) intensity of competition, (2) competition in mixed populations, (3) the influence of environment upon competition in mixed cultures, and (4) the rôle of the quantitative relations between species at the beginning of their struggle. Among animals the processes of the struggle for existence are much more complex, and as yet one cannot speak of any general principles. In this connection an investigation of the elementary processes of the struggle for existence in strictly controlled laboratory conditions is here particularly desirable . . . .

In the third chapter the struggle for existence is discussed from the mathematical viewpoint. Here the author's material shows the influence of the work of Pearl, Lotka and Volterra. Gause discusses the calculation and significance of two types of mathematical constants: the coefficients of multiplication, b_1 and b_2, and the coefficients for the struggle for existence α and β. These constants are used in developing differential equations describing the struggle for life; equations which start out as comparatively simple expressions dealing with an idealized situation but which soon add complication upon complication to meet the demands of the increasing complexity associated with the struggle for existence. Gause is quite aware as to the futility of applying mathematical methods of description to complex cases of competition. This leads him to deal entirely with experimental yeast and protozoan populations in which he feels the mathematical technique is justified.

In the last three chapters of the book Doctor Gause discusses respectively the growth of yeast populations and the competition existing in such populations between the yeast cells; the competition for common food exhibited by growing cultures of protozoa (*Paramecium* sps., *Stylonychia*), and the predator-prey type of struggle for existence exemplified by *Didinium*, the predator, and *Paramecium*, the prey. It would be pointless to discuss here many of the author's findings on these matters. Suffice it to say that, in not-a-few instances, the theoretical equations describing the various phases of the struggle for existence are completely substantiated by the actual experimental data. This seems to hold especially true for the simpler conditions of experiment.

Of particular interest, however, and worthy of more detailed treatment, is Gause's discussion of the predator-prey type of population interaction. The mathematicians, Lotka and Volterra, have developed equations which describe the struggle for existence when two species, one a predator, the other the prey, inhabit the same microcosm. These equations lead to the prediction that the numbers of prey and predators will fluctuate in definite cycles of abundance and sparseness due to innate properties of the biological system itself not related to external environmental forces. The story, as described by the mathematicians, runs something like this: if, in a limited environment we have n_1 number of prey, and, if an n_2 number of predators are introduced into the system, the concentration of the prey diminishes and that of the predators increases. However, as the predators increase they devour more and more of the prey so that the latter become fewer in number. This creates a food shortage for the predators and most of them die off. As a result, the pressure on the prey is relieved and they increase rapidly, soon becoming the more numerous species. The few predators which did survive their food shortage now flourish and multiply abundantly and so the cycle is reconstituted. In chapter VI Doctor Gause is interested in seeing if these "classical" oscillations of predators and prey, predicted on a stochastic basis, can be realized by actual experimental data. To do this he chose two infusoria which live under similar ecological conditions: *Didinium nasutum* and *Paramecium caudatum*, the predator and the prey respectively. The former species requires for its nutriment a fresh *Paramecium* every three hours. The bacterium, *Bacillus pyocyaneus*, was always present in the medium of this and subsequent experiments to supply the *Paramecia* with food. In the first experiments five *Paramecia* were placed in a clear oaten medium and two days later three of the preying *Didinium* were added. After the introduction of the predators the number of *Paramecia* decrease, the *Didinium* multiply, intensely devour all the prey, and then themselves starve to death. Clearly this experiment offers no support to the predictions of the mathematicians and furnishes no evidence of an innate periodic oscillation of numbers for such a system. Gause has this interesting observation to make:

> However, why is the theoretical equation of the mathematicians not realized in our case? The cause of this is apparently that a purely biological property of our predator has not been taken into account in the equation. According to this equation a decrease in the concentration of the prey diminishes the probability of their encounters with the predators, and causes a sharp decrease in the multiplication of the latter, and afterwards this even leads to their partly dying out. However, in the actual case *Didinium* in spite of the insufficiency of food continues to multiply intensely at the expense of a vast decrease in size of the individual.

This matter was tested further experimentally by slightly changing the medium in order that some of the *Paramecia* could escape from the *Didinium*. This experiment was developed on the grounds that the more heterogeneous environment simulated the natural conditions more closely. The change was brought about by using a medium containing a sediment in which the prey was free to go but which barred the predators. Under these conditions all of the *Didinium* would be found in the clear part of the medium and the *Paramecia* would be moving in and out of the sedimentary deposits. In short, the system provides the prey with a "refuge." For the majority of cases the results of this experiment were clear cut. If *Paramecia* and *Didinium* are simultaneously introduced into the microcosm the latter increase somewhat and devour some of the *Paramecia*. A considerable group of the prey, however, escape into the sediment and there cannot be attacked. The *Didinium* soon eat all of the *Paramecia* in the clear part of the medium and then starve. In the meantime, the havened *Paramecia* have multiplied greatly and soon the culture becomes entirely composed of this species. Here again, under presumably more "natural" conditions, the "classical" results do not obtain.

In his third group of experiments Doctor Gause uses the clear oaten medium and at the beginning and every third day thereafter added one *Paramecium* and one *Didinium* to the culture. Under these conditions an actual experimental oscillation of the predators and prey was demonstrable with first the *Paramecia* being most numerous and then the *Didinium*. The author's final word on this matter is,

> The above given example shows that in *Paramecium* and *Didinium* the periodic oscillations in the numbers of the predators and of the prey are not a property of the predator-prey interaction itself, as the mathematicians suspected, but apparently occur as a result of constant interferences from without in the development of this interaction. There is evidence for believing that this is characteristic for more than one special case.

This is a splendid book deserving of welcome by the ecologist, the population student, the physiologist, the student of evolution, and the theoretical biologist. It attacks a fundamental problem, uses skillful weapons and methods in its attack, and arrives at some interesting and frequently provocative conclusions. Despite the author's gifts in the mathematical field he seems admirably wary of extending his calculations beyond the confines of his experimentation: this is one of the book's chief attributes. Many of the experiments reported are original and good use is made of the bibliography on yeast and protozoa population problems. An appendix, detailing the technique of making the mathematical calculations, is also useful. The book is not, on the whole, an easy one to read: this is partly due to the complex nature of the problem and the technical manner in which the material is treated. In the reviewer's opinion a final chapter presenting the author's matured conclusions and generalizations on the subject would have been helpful to the reader. The volume would have been better technically had the graphs, figures, and lettering been more meticulously prepared. Two mistakes in usage of proper names were noticed in the text: "Calcins" for "Calkins" and "Nikolson" for "Nicholson."

The book ends on a note of pessimism and so may this review by quoting the last paragraph:

> It is to be hoped that further experimental researches will enable us to penetrate deeper into the nature of the processes of the struggle for existence. But in this direction many and varied difficulties will undoubtedly be encountered.

BRIEF NOTICES

EVOLUTION

STUDIES OF THE PLEISTOCENE PALAEOBOTANY OF CALIFORNIA. *Contributions to Palaeontology. Carnegie Institution of Washington Publication No. 415.*

Carnegie Institution of Washington, D. C. $3.00 (paper); $3.50 (cloth). 10 x $6\frac{7}{8}$; 179 + 31 plates; 1934.

Four papers are contained in this volume: A Pleistocene Flora from Santa Cruz Island, California, by Ralph W. Chaney and H. L. Mason; A Pleistocene Flora from San Bruno, San Mateo County, California, by Susan S. Potbury; A Pleistocene Flora from the Asphalt Deposits at Carpinteria, California, by R. W. Chaney and Herbert L. Mason; Pleistocene Flora of the Tomales Formation, by Herbert L. Mason.

Although something has been known of the geology of the Island of Santa Cruz since 1890, fossils have been noted only recently. Their occurrence in Pleistocene alluvial deposits is important in determining early distributions of modern trees. All nine of the species described in this paper are still living in California.

The second paper describes several shrubs and herbs not previously recognized as fossil in North America. All the species are living in California but not all in the immediate neighborhood. There are indications that the climate of the region described has been gradually becoming drier since Pleistocene times. There are marine deposits under the plant-bearing beds at San Bruno.

The first fossils in the Carpinteria deposit were discovered in 1927 although asphalt had been mined here for a long time before. This paper describes 25 species, nearly one fourth of them being herbs, which are usually rare in fossil deposits. Various animal remains associated with the above mentioned plants have been helpful in determining the age of the deposits and the general ecology of the Pleistocene.

The last paper is concerned with the plant fossils in the area where the earthquake of 1906 took place. The geology and the fauna of the region have been studied previously but the flora had been neglected. There is an interesting although brief account of how the fossil remains are prepared and identified. The importance of ecological relationships is stressed.

* * *

THE GREAT DESIGN. *Order and Progress in Nature.*

By various authors. Edited by Frances Mason. The Macmillan Co., New York. $2.50. $7\frac{3}{4}$ x $5\frac{3}{8}$; 324; 1934.

The essays in this volume were written in reply to a question, "Is there a Living Intelligence behind Nature, or does the great Cosmos somehow run itself, driven by blind force?," or as J. Arthur Thomson, one of the contributors, paraphrased it, "Is the scientifically disclosed world of order and intelligence one in which the religious mind can breathe freely?" A group of eminent scientific men wrote answers characterized by a degree of shrewd evasiveness that is not likely to add luster to their reputations. Several of them wrote popular scientific articles, expounding in scholarly fashion the provisional and speculative nature of our knowledge of the fundamental concepts of matter, energy, and life, and the only way by which their sympathy with the religious point of view is displayed is by the inclusion of some such sentence as, "For, as St. Paul truly said, one star differeth from another star in glory," put in as though by afterthought, or by tacking on a paragraph or two at the end in quite a different literary style. Gager (p. 184) expressed a general attitude when he wrote, "I have not set out to attempt a definite answer to the question of whether there is 'mind-back-of-it-all,' but only to set forth the kind of facts and certain considerations which must be weighed if one wishes to face the question with his reason as well as with his emotions. There is no other justification in putting the question up to science at all." Only a few contributors really come to grips with the questions put to them, Lodge, Younghusband, and Fraser-Harris among them, and occasionally they reason as cogently as Paley. The consensus of opinion of this group of uncertain amateur theologians is that no one is bound to accept an answer to this question that is displeasing to him.

* * *

Men of the Dawn. *The Story of Man's Evolution to the End of the Old Stone Age. The Thinker's Library No. 45.*

By Dorothy Davison. Watts and Company, London. 1 shilling net. 4 x $6\frac{7}{8}$; xii + 195; 1934.

This excellent little book deals with the evolution of the primates up to man and the skeletal remains and culture of paleolithic man. Especial attention is given to the art of the old stone age and the recent discoveries in Africa. There is a bibliography of two pages and an index.

* * *

GENETICS

Die Kinder Männlicher und Weiblicher Morphinisten. (*Frage der Keim- und Fruchtschädigung, Erbgang der Psychopathie*).

By Kurt Pohlisch. Georg Thieme, Leipzig. 5.80 marks. 10 x $6\frac{5}{8}$; 82; 1934 (paper).

The author has analyzed genetically 1929 adult morphine addicts—1348 male and 581 female—and examined for mental and physical defects the children produced before or after the period of addiction, and those produced during this period. The comparison between the two groups of children showed no significant differences. There was a rather high percentage of defectives in both groups, but when parents and other relations were analyzed, similar high percentages were obtained. Furthermore, the descendants of four addicts were traced with similar results. These observations indicate that the defects in the children were not due to the use of morphine by the parents.

Observations on 62 addicted mothers as to course of pregnancy and confinement showed that there was an increase in fetal movements when the usual dose was decreased or delayed; premature births were frequent; abstinence symptoms appeared in the infants shortly after birth, especially when they were deprived of mothers' milk from which they apparently received an amount of morphine; and the infant mortality rate was high. During the first month development was retarded, but thereafter progressed normally.

* * *

Breeding and Improvement of Farm Animals. *Second Edition.*

By Victor A. Rice. McGraw-Hill Book Co., New York. $4.00. 9 x $5\frac{3}{4}$; xiii + 516; 1934.

A text-book is, in the nature of the case, bound to be a compilation of the work of many authors and a certain amount of direct quotation is illuminating and interesting. But when the work quoted is current and not difficult of access, it does seem unnecessary to carry the quoting habit to quite the extreme that Rice does.

The first edition was reviewed in Volume 2, Number 3, of The Quarterly Review of Biology. The chapter headings of the present edition are the same as in the earlier one but considerable new material has been added—154 pages in fact. The various sections dealing with genetics have been expanded (some problems from Sinnott and Dunn's genetic text are included for one thing) but the largest proportion of added material concerns the selection of animals for breeding. There is quite a bit of discussion of various plans proposed for breeding better producing animals.

Since this book covers such a wide field —genetics, physiology, biometry, and the "art of breeding"—it must of necessity be elementary and dogmatic in spots. This seems especially noticeable in respect to biometry and physiology.

* * *

Beef Production and Quality as Influenced by Crossing Brahman with Hereford and Shorthorn Cattle. *U. S. Department of Agriculture Technical Bulletin No. 417.*
By W. H. Black, A. T. Semple, and J. L. Lush. U. S. Government Printing Office, Washington. 10 cents. 9 x 5¾; 54; 1934 (paper).

A series of experiments ranging fom one to three years in duration designed to compare crossbred Brahman-Hereford and Brahman-Shorthorn steers with straight Hereford and Shorthorn steers with respect to feeding habits, market desirability, size and weight, and economic value of meat produced. No very significant differences came out of the experiments, but the general feeling of the investigators was that the variations between the breeds indicated that beef cattle could be improved in feed-lot efficiency and quality of meat if more breeding experiments were carried out.

* * *

Heredity and Disease.
By Otto L. Mohr. W. W. Norton and Co., New York. $3.50. 8½ x 5½; 253; 1934.

A concise exposition of the history and principles of genetics written especially for medical students and physicians. It well fulfills its aim; being clear and interesting, and above all praiseworthy for the sober and rational manner in which the author considers the problems of human heredity.

Natürliche Zuchtwahl. *Volk und Wissen, Bd. 15.*
By Hans Stubbe. Brehm Verlag, Berlin. 90 Pfennig. 8½ x 5⅝; 29; no date (paper).

The fundamentals of genetics are discussed with the aim of justifying the eugenic and sterilization program of the Third Reich.

* * *

Der Erbarzt. I. Jahrg., Heft 1.
Edited by O. Freiherr von Verschuer. S. Hirzel, Leipzig. 2.80 marks for 3 numbers (6 numbers appear per year); 1 mark, single copy. 11⅞ x 8½; 32; 1934.

* * *

GENERAL BIOLOGY

Traité de Climatologie *Biologique et Médicale. Vols. I, II, III.*
Published under the direction of M. Piéry; assistant editors M. Milhaud and R. Van der Elst. Masson et Cie, Paris. 300 francs per set. 10 x 6½; xlix + 2664; 1934 (paper).

These massive volumes, prepared by the cooperative effort of some 140 collaborators working under the general editorial direction of Professor Piéry, constitute a reference work on the biological effects of climate that no biological, medical, or hygienic library can afford to be without. In fact it is unique and invaluable.

The subject matter is ordered in nine books. The first (including about 250 pages) deals with the physics and chemistry of climatology. The second discusses general climatography, for Europe in particular and the globe in general. Bioclimatology (phyto- and zoo-) occupies Book III, while Book IV is devoted to the general principles of human climatology. Book V discusses in some 400 pages physioclimatology, general and special; while Book VI deals with general and special climatopathology. The last three main divisions of the treatise are of specially medical interest, dealing respectively with the techniques and methods of climatic "cures"; medical climatography; and clinical climatotherapy.

The book is abundantly illustrated, thoroughly documented bibliographically, and extremely well edited and printed. It ends with an index covering 52 pages, double column, set in 8-point type. In short it is a treasure that has our unreserved recommendation.

Half Mile Down.

By William Beebe. Harcourt, Brace and Co., New York. \$5.00. $9\frac{1}{4}$ x 6; xix + 344 + 44 plates; 1934.

The title of Dr. Beebe's book *Half Mile Down* indicates the record which he established while making dives in the bathysphere. He begins with an historical account of man's devices to submerge himself, tells of his own experiences diving with a helmet and then devotes himself to describing the bathysphere dives from all points of view. His account of the actual technique used is interesting, but becomes wearisome as he repeats it upon every occasion on which the bathysphere goes down. The gradual reduction in the number of colors of the spectrum as one descends, and the reaction of the fish to his beam of light are discussed. Some fish are attracted by it, some are frightened and others are completely indifferent. The latter reaction he concludes is due to the complete absence of change in the quality of darkness at great depths.

The book is popularly written and the appendix contains detailed notes on two dives, a classified résumé of organisms observed and technical information on the bathysphere and its operation. There is a good index.

Our chief criticism of the text is that it is unnecessarily verbose.

Exploring with the Microscope.

By Raymond F. Yates. D. Appleton-Century Co., New York. \$2.00. $7\frac{3}{8}$ x 5; xv + 182 + 15 plates; 1934.

Addressed to amateurs, this fascinating book tells what to look at under the microscope and how to do it. Along with the "how to do it," directions are given for making certain simple adjuncts to add to one's equipment, such as a microtome and a polariscope. It really serves as a laboratory guide to those whose laboratory is the kitchen table.

The author accomplishes very successfully the difficult task of making a technical subject simple without talking down to his audience and without using a bedtime story style. The book does not aim to teach biology but it would be surprising if it did not stimulate many of its readers to study the subject further.

Confessions of a Scientist.

By Raymond L. Ditmars. The Macmillan Co., New York. \$3.50. $8\frac{1}{2}$ x $5\frac{3}{4}$; xii + 241 + 4 plates; 1934.

If you are a biologist, interested in what animals really are like, or if you are a mystery story writer in search of a plot, or if you are merely a reader who likes a vivid, well-told tale,—this is a book well worth your time.

Ditmars' discovery that the vampire bat laps up blood instead of sucking it, is here retold in some detail as is his subsequent discovery that the observations had been made before. How the author felt when he lectured before the National Geographic Society at Washington and how he served his apprenticeship on a newspaper are some of the less scientific but not less interesting confessions.

Biologischer Wille. *Wege und Ziele biologischer Arbeit im neuen Reich.*

By Ernst Lehmann. J. F. Lehmann, München. 2.50 marks. $7\frac{1}{2}$ x $4\frac{7}{8}$; 113; 1934 (paper).

Lehmann, the Director of the Botanical Institute at Tübingen, believes that, as in the nineteenth century idealistic philosophy became the unifying character underlying the German universities, so at the present time biological thought is becoming the pervading element. In this book he traces the trends of biological teaching not only in the schools, but also in the cultural, scientific and even political life of the German people. He offers suggestions for the course of study from the primary schools on up through the universities, and lists numerous vocations in which a thorough biological training would be of great benefit.

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Travaux du Laboratoire de Microbiologie de la Faculté de Pharmacie de Nancy. *Fasc. VII.*

50 francs. $9\frac{1}{2} \times 6\frac{1}{4}$; 234 + 15 plates; 1934 (paper).

HUMAN BIOLOGY

Chan Kom. *A Maya Village. Carnegie Institution of Washington Publication No. 448.*

By Robert Redfield and Alfonso Villa R. Carnegie Institution of Washington, D. C. $4.25 (paper); $5.25 (cloth). 12 x 9; viii + 387 + 16 plates; 1934.

This is a detailed monographic account of the life of a peasant village, Chan Kom, in Yucatan. This village has a total population of 251 (131♂ and 120♀) of which 48.6 percent are under 15 years of age, and only 4.8 percent 50 or more years old. Natality and mortality are both high. Contraception is apparently unknown. The people are racially homogeneous in high degree, conforming to the Maya Indian type. Whatever admixture of white blood there may have been in the past, it must have been small. Since Chan Kom is situated in a zone between the henequen and the chicle areas, the people work only for themselves. They raise corn which they either consume or sell or barter for manufactured goods; and for the rest they hunt, keep bees, poultry and hogs, and to some extent other livestock. There is little of either wealth or inequality in its distribution, but still individual differences in ability do make themselves apparent in worldly goods. There is a good deal of communal labor and effort generally. *Fagina* is the name for the labor that every man in the village has to give, without compensation, for the public good.

> The performance of *fagina* is attended with the impressiveness of collective determination and the stimulus of a situation where all men work shoulder to shoulder on one common task. When *fagina* has been decided upon, all the men meet at the *cuartel*, and first taking note of any absentees, that derelictions may not go unpunished, they go off together, with their tools, to the place where the task is to be done. At the meeting the night before when *fagina* was decided upon, there have been speeches exhorting the people to special effort that Chan Kom may grow in power and prestige, these words are still in the ears as they go out to do the work, and perhaps the *comisario*, who is with them as their leader, urges them on with fresh exhortations. During the work there is plenty of opportunity to talk and to joke; *fagina* is permeated by a cheerful enthusiasm.

In sum, it is a primitive people living in a primitive state of culture that this volume describes. The description is minutely detailed, and covers practically every aspect of life. Indeed the most important criticism of the book is that no attempt is made at any point towards a general synthesis of the results into a unified picture. The intertwined threads of fact are left in a tangled skein. Nor is there much offered in the way of comparison with other peoples and cultures. And surely ethnology and sociology are comparative sciences. A description of a particular people or a particular culture, however meticulous, has little meaning except as it serves to establish relationships to others. To be sure the authors specifically state that this volume is but the first in what is hoped to be a comparative study of Mayan cultures. But even so it would seem to have been possible, and profitable, to have been even at this stage a little less detached.

Two very interesting and valuable features of the book are (a) an autobiography contributed by Eustaquio Ceme, the only man in the village sufficiently literate to write such a document. He is one of the three *principales* of Chan Kom, and its outstanding civic leader. He is a successful man and proud of it. The other document is (b) the diary kept by the junior author, who is the village school master, from February 16, 1930 to November 21, 1931.

The volume closes with a glossary of plant and animal names, a short bibliography, and a detailed index. As a contribution of factual material for future synthesis and comparative research it stands in the first rank.

Jöns Jacob Berzelius. *Autobiographical Notes.*

Published by The Royal Swedish Academy of Sciences through H. G. Söderbaum. Translated from the Swedish by Olof Larsell. The Williams & Wilkins Co., Baltimore. \$2.50. 8 x $5\frac{1}{2}$; xi + 194 + 3 plates; 1934.

Of this autobiography of Berzelius, written in fulfillment of a requirement of the Swedish Academy of Sciences, three manuscripts are extant. In his school and college years his interest in natural history and chemistry, which led him to neglect some of his other studies, did not meet with the sympathy of some of his teachers. For a number of years after his graduation in medicine he found it difficult to make ends meet. His attempts to supplement his meager stipend by lectures on chemistry brought in little money, but in time his chemical researches gained him fame and a comfortable income. There are interesting accounts of Davy, Young, Goethe and others whom Berzelius met in his travels. Davy had married a rich widow and was growing more interested in shining as a man of fashion than as a chemist. Berzelius had annotated his copy of Davy's *Elements of Chemical Philosophy*, which had just been published, with criticisms of some of the author's statements. Later he visited Young at his country estate at Worthing.

> When I came down quite early on the following morning into the living room I found Young occupied with entering into his own copy of the book by Davy the marked places in mine. At my question as to why he did this he answered quite frankly that he desired to talk with me about the items which were marked. He had undertaken to review the book for a literary journal and believed that a thorough criticism of it would be nothing more than justice to the author, who had been made arrogant by success. I declared then that in such a case he should receive no explanation of the notations which had been made. I represented to him that such a criticism could possibly awaken in Davy a distaste for science, since he had already given reasons to fear that he intended henceforth to occupy himself less than formerly with chemical investigations. Further I reminded him of Chevenix, who, because of the criticism he had received in scientific circles as a result of an attempt to produce palladium artificially, had permanently given up his work in chemistry, as he himself had assured me a few days previously. Young admitted the correctness of these remarks and added that Davy was even more sensitive than Chevenix. The following morning he read me his review in which, with just but perhaps somewhat too far-driven praise, he set forth the new views laid down by Davy in the book. He then requested explanations of my notations at the marked places, to be subjects only for his own information. I gave them to him in confidence, but when Davy returned, some time after my homeward journey, Young sought him in order to win his closer friendship by bringing my notations to his knowledge. Through this a feeling of hostility against me was awakened in Davy, which indeed became milder in time but never was fully dispelled.

The book also contains parallel passages from the other two manuscripts and explanatory notes by the editor. It is illustrated with a portrait of Berzelius, a photograph of his birthplace, and a facsimile of a page of his manuscript. There is no index.

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Races, Nations and Jews.

By Joseph Tenenbaum. Bloch Publishing Co., New York. \$2.00. $7\frac{3}{4}$ x $5\frac{1}{4}$; x + 170; 1934.

The author of this book, a Jewish leader in Eastern Europe who served as medical officer in the Austro-Hungarian army for four years, came in 1920 to New York. While still practising surgery he devoted much time to the study of the social and economic problems of the Jewish people. In this book he first discusses what factors and conditions go into the development and maintenance of races and nationalities. If the Jews are to be considered as a race there can be no Jewish race purity because of the blending which has taken place from the time the Hebrew nomads first drifted into Palestine about 1400 B.C. on down through the centuries wherever their descendants made their homes. The "Semitic nose" was acquired through intermarriage with the Canaanites. Today the Jews "of various countries differ among themselves more than they do from the Gentile populations of the same countries." Concerning the nationality of Jews (and other peoples as well) he believes that the "only criterion that can be relied upon to identify the true background of nationality is the fact of being national-conscious." . . . . "To deny the existence of a Jewish nationality is to deny the very meaning of nationality."

The latter part of the volume is concerned with nationalism, supernationalism and anti-semitism; statistics, statics, and dynamics; and socio-economic problems of the Jews in America. Among the numbers of Jews in the different countries of the world we find that the United States has the greatest number, something over 4,000,000 (3.5 percent of the total population); Poland 3,000,000 (10.4 percent of the total population); England and Ireland 320,000 (0.7 percent of the total population), and Canada 170,000 (1.4 per cent of the total population).

In the final chapter a plea is made for "the cohesive power of national consciousness embracing world Jewry as one indivisible unit. *It is to the best interests of the nations and humanity in general that there shall be a free, national-conscious and united Jewish people.*"

The volume is without index.

Dynamics of Population. *Social and Biological Significance of Changing Birth Rates in the United States.*

By Frank Lorimer and Frederick Osborn. The Macmillan Co., New York. $4.00. $9\frac{1}{4}$ x $6\frac{1}{4}$; xiii + 461; 1934.

In the opinion of the reviewer this is one of the best and most systematic studies of qualitative population trends yet to be published. It is an unprejudiced survey based on critical analysis of hundreds of factual studies recently made on population and eugenic problems. The authors, one feels, have no axe to grind, but are presenting only data that can be measured with scientific accuracy, and sifting out conclusions which are therefore all the more forceful.

The book divides into four parts. Part I, "Population Trends of American Groups," deals with fertility in relation to size of community, race, nativity, occupation and economic status; Part II, "Measurable Characteristics of American Groups," concerns variations in health, culture and intellect among different racial and regional groups; Part III, "Influences of Differential Reproduction of the Characteristics of the American People," and Part IV, "The Causes and Controls of Population Trends." In chapter 14, devoted to conclusions, the authors say

> In general, it is evident that those who enjoy the greatest cultural resources are not having enough children to replace themselves in the next generation, and that the most undeveloped groups in our national life are the chief sources of population increase. Moderately high reproduction rates are found in agricultural areas with high indices of cultural-intellectual development, but the population included in such areas is certainly less than half of the total farm population of the nation. And, with the exception of a few sparsely populated states in the Rocky Mountain division, the states with conspicuously high reproduction rates are also characterized by very low ratings on indices of cultural-intellectual level.

The Second-Generation Japanese Problem.

By Edward K. Strong, Jr. Stanford University Press, Stanford University, Calif. $3.25. $8\frac{3}{4}$ x 6; viii + 292; 1934.

A special study of the educational and vocational opportunities offered the second generation Japanese in California was made by the author and collaborators and published elsewhere in full detail. This book contains a summary of the results and conclusions. It is clearly evident that on the average the American born Japanese differs very little or none at all from his white contemporaries in mental or moral qualities. His physical characteristics are the apparent cause of any discrimination against him. How great is this discrimination cannot be known. It is practically always denied by the whites, nevertheless the Japanese feel that it is universal. The opportunities for the future, according to the author, depend on the degree of racial prejudice and in California, at least, do not appear very good. All indications suggest that it is best for the youngsters to follow the occupations of the fathers, who in late years have shown a tendency to leave farming in favor of small business. It is of interest to note that the chances of true assimilation with the whites are practically impossible because the *Japanese* frown on mesalliances. The idea of a people within a people should not be alarming when one considers that there is no more immigration. The Japanese are after all few in number and their fertility is declining.

Although the results are as expected, this investigation has been well conducted and deserves to be used as a model for similar studies on other racial groups.

* * *

Enquête sur les Conditions de Vie des Familles Nombreuses en Belgique.

Analysis of the results by Aimée Racine, Preface by Ernest Mahaim, Sociological conclusions by Eugène Dupréel. Recueil Sirey, Paris. 20 francs. $9\frac{3}{4}$ x $6\frac{3}{8}$; 175 + folding plate; 1933 (paper).

It is a fact that large families are anachronistic in our present society. The Belgian Committee of the International Population Union has therefore conducted an enquiry on 140 families, each composed of 5 or more children, for the purpose of investigating their social and economic status and especially the mental attitude of the parents. The selection of the material and the form of questionnaire are not above criticism as admitted by Professor Dupréel, who draws the sociological conclusions. These show that the mother is the nucleus around which the family moves, but the moral and mental qualities of the father are those which determine the status of the family. So, there are two classes of prolific families: One, in which the father has a firm conviction of the desirability of having many children and the satisfaction of thus serving God and his country. This accompanies a higher economic and social level. The other category of families includes those beset by poverty, disease and ignorance, and fathered by weak men, each of whom has a large family because he does not know how to avoid it.

The writers, limited by their theme, have failed to make it clear that the association between the qualities of the fathers and status of the family is probably not particular to prolific families.

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Five Hundred Delinquent Women.

By Sheldon and Eleanor T. Glueck. Alfred A. Knopf, New York. \$5.00. $9\frac{3}{8}$ x $6\frac{1}{4}$; xxxiv + 539; 1934.

This is the first of a series of studies projected under the auspices of the Institute of Criminal Law of the Harvard Law School. Roscoe Pound contributes an introduction. The book deals with a "detailed survey of the background and traits of delinquent and criminal women, of the peno-correctional treatment to which such offenders are subjected, and of the practical results of such treatment in terms of reform or recidivism." Also, there is an inquiry into the response of various classes of offenders to the different types of peno-correctional treatment actually provided by society. It is impossible to give in a brief space any conception of the highly adequate way in which this survey has been made but for thoroughness in the collection of material and in critical judgment in sifting results the work stands as a model for all those undertaking studies along similar lines. The authors stress the fact that at present too little is known about the "basic problem of the relative rôles of heredity and acquired qualities in the disposition and behavior of human beings" for adequate methods to be applied successfully to delinquents and that it is of the "utmost importance that careful biologic and sociologic research and experimentation go hand in hand with 'practical programs' designed to 'produce immediate results.' " Fully two-fifths of the volume is concerned with *Methods of this research* (Appendix A) and *Schedules and forms* (Appendix B). The foot-notes, references and detailed index add to its usefulness.

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Population Theories and Their Application *with Special Reference to Japan.*

By E. F. Penrose. Food Research Institute, Stanford University, Calif. \$3.50. $8\frac{5}{8}$ x $5\frac{5}{8}$; xiv + 347; 1934.

The contents of this book are divided into three parts: Part I, "Theories of population"; Part II, "Some aspects of the Japanese population problem," and Part III, "The distribution of population and the distribution of natural resources." The book is economic in emphasis, stressing such problems as agriculture, industrialization, territorial expansion, and international trade. Coming at the present time, when the problems of Japan are so real to the civilized world, the book will at least attract many and varied readers if not make friends. One of the author's important viewpoints may be put in his own words:

> Some thinkers have held that war and other social conflicts arise out of blind impersonal forces inherent in nature and beyond human control. For a time it was held by many that an instinct of pugnacity belonging to man's biological inheritance made war inevitable, but this view is now discredited in scientific circles. Many population students, however, have held that the reproductive capacity of man is so far in excess of his productive capacity that the pressure of numbers on productive resources is a standing menace to world peace and to social harmony. Actually, productive capacity is the one thing which shows no sign of failing, while reproductive capacity is now being brought so rapidly under individual control that over wide areas fertility rates have fallen below replacement level.

* * *

CONSTRUCTIVE EUGENICS *and Rational Marriage.*

By Morris Siegel. McClelland and Stewart, Toronto. \$2.50. $7\frac{1}{2}$ x $5\frac{1}{8}$; xiii + 196 + 2 plates; 1934.

It is not possible for one to agree with all of the tenets of this book. Nevertheless the author's main contention that there should be an educational program to instruct the young to make certain discriminations in choosing mates is sound. In the olden days, the custom for marriages to be arranged by the parents had as a rule a definitely beneficial effect upon the type of offspring produced. Nowadays, when parental authority in matrimonial affairs is significantly small the author believes that the following program is promising of good results:

> Compulsory teaching of eugenics in Middle and Higher Schools; More extensive instruction in heredity and eugenics for undergraduates in Medicine, Post Graduate courses in heredity and eugenics, for the training of specialists; Propaganda; Federal or Dominion Eugenic Department.

The volume is indexed. Chancellor Whidden of McMaster University of Canada contributes an introduction and Drs. J. R. Parry and Morton of Hamilton, Ontario, a foreword.

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MATERNAL MORTALITY IN PHILADELPHIA 1931–1933. *Report of Committee on Maternal Welfare, Philip F. Williams, Chairman.*

Philadelphia County Medical Society, Philadelphia. \$1.00. 9 x 6; 144 + 4 folding charts; 1934 (paper).

In order to make this study comparable to that in progress in New York the line of survey and analysis which was in use by the Committee of Public Health Relations of the New York Academy of Medicine was adopted. For the three years (1931, '32, '33) there occurred in Philadelphia 717 maternal deaths to 99,579 total births. Eliminating 78 non-obstetrical causes of deaths there remained a puerperal death rate of 6.69 per thousand live births. Of the 639 deaths, 529 occurred in white women and 110 in negroes. The data concerning the causes of these deaths have been collected and analyzed with the utmost care and presented in tabular and graphic form in the report. The latter part of the study deals with recommendations and discussion. It is the intention of the Committee to continue the survey for three more years during which time the members of the Committee on Maternal Welfare and the Auxiliary Analysis Committee may have time to bring before the hospital staffs and medical societies their findings and recommendations. This admirable report might well serve as a model for similar surveys in other large centers of population in the United States.

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THE DOCTOR IN HISTORY.

By Howard W. Haggard. Yale University Press, New Haven. \$3.75. $9\frac{1}{4}$ x 6; xiii + 408; 1934.

This "history of health," the author tells us in the preface, was written for his children in order that they might be able to think "logically and soundly on the social matters of medicine in these years of faddism, quackery and commercially exploited 'health appeal'." He believes that the student should have a thorough knowledge of man's greatest and longest struggle from earliest times, namely, to survive against disease, as well as a knowledge of the history of man's struggle against man or against geographical barriers. Too often the study of present day hygiene consists in the glib recitation of the dicta of today "many of which will surely become the absurdities of tomorrow." Beginning with the earliest known methods of healing; namely, magic, mystery and superstition, the author leads the reader on through the centuries, pointing out the various fashions in medicine and sifting out those methods which have proved to be of permanent value. The great contributors to medicine are arrayed beside the great quacks. The book is interestingly written and abundantly illustrated and indexed. An excellent volume for general and high school libraries.

THE CHILD. *His Origin, Development and Care.*

By Florence B. Sherbon. McGraw-Hill Book Co., New York. $3.50. 8 x 5½; xix + 707; 1934.

This book, by the Professor of Child Care and Development in the department of home economics in the University of Kansas, was written for students who have had no special training in biology. It is an endeavor "to present the whole child, from his earliest origins until we lead him to the schoolroom door." Picking at random one finds such topics discussed as heredity, evolution of reproduction, glands of internal secretion, hygiene of pregnancy, birth of the child, hygiene of childhood, the brain, theories of behavior and learning, etc. etc. Occurring with considerable frequency throughout the text are poetic quotations which have some sentimental bearing on the subjects under discussion. One is considerably amused to read the author's advice in the preface. The student is urged to spend the first week merely reading steadily through the text. "Especially read the poetry now, and again and again. The poet is a true scientist and often gives us in a magic flash of words the gist of a weighty scientific tome." The volume is abundantly illustrated and documented and contains numerous tables and charts. In a series of appendixes are discussed basal metabolism, anaesthetics used in child birth and immunization. There is also a glossary and a detailed index. Undoubtedly a useful volume for the purpose for which it was designed.

PATTERNS OF CULTURE.

By Ruth Benedict. Houghton Mifflin Co., Boston. $2.50. 8⅛ x 5½; xiii + 291; 1934.

In this interesting book Dr. Benedict develops the thesis that the culture of a society cannot be understood by cutting it up into isolated categories, such as economic life, religion, and the like, that different cultures have different dominating ideas which integrate the approved behavior in the different departments of social activity. She has therefore chosen for analysis three contrasting primitive cultures, the Zuñi Indians of New Mexico, the Dobuans of Melanesia, and the Kwakiutl of British Columbia. The Zuñi believe in the golden mean and in self-effacement for the sake of society. In Dobu suspicion and enmity are the dominating ideas. The good man is the one who by his potent sorcery has got the best of his neighbors. The mainspring of Kwakiutl society is self-glorification. The conspicuous waste of their potlatch feasts would shame a millionaire of the Mauve Decade. It is evident that a personality that would fit in well among the Kwakiutl would be sadly out of place among the Zuñi and vice versa.

The book contains an introduction by Dr. Franz Boas, eight pages of bibliographic notes and an index.

SECRETS OF SIBERIA.

By Pierre Dominique. Translated from the French by Warre B. Wells. Hutchinson and Co., London. 10s. 6d. net. 8½ x 5⅜; 288; 1934.

No one with a real interest in the Soviet régime should fail to read this book which so fairly and so clearly depicts the efforts which are being made to industrialize Siberia along American lines and to "collectivise" the peasantry in order to feed the working population of the new towns. The author, a keen observer and an interesting writer, conveys to his readers perhaps more effectively than has ever been done before just what is taking place in this colossal effort to swing large groups of peoples with centuries of background for particular types of life 'about face' within a period of a few years. That there was bound to be wastage of life and property, intense suffering and discontent must have been foreseen by the zealous Communist leaders, but did they comprehend the enormity of their task in mechanizing mankind? Again, one is compelled to urge the serious student to read of the great Asiatic experiment as presented in this book. The volume is illustrated but is without index.

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The So-called Wends of Germany and Their Colonies in Texas and in Australia. *The University of Texas Bulletin No. 3417. Bureau of Research in the Social Sciences Study No. 7.*

By George C. Engerrand. University Publications, University of Texas, Austin. Free. $8\frac{3}{4}$ x $5\frac{7}{8}$; 179; 1934 (paper).

From about the sixth to the tenth century the eastern part of what is now Germany was inhabited mainly by Slavic-speaking tribes. From the tenth century on these tribes were conquered by the Germans and largely Germanized so that the only group which retains its Slavic language is the Wends of Lusatia. The first part of the book describes their culture, the efforts of the Germans to assimilate them and the counter-efforts of the Czechs and others to secure their independence or autonomy.

In 1854 a group of Lutheran Wends who did not relish the union of the Lutheran and Reformed churches which had been decreed by the Prussian Government, emigrated to Texas. The second part of the book gives the history of their settlements in this new environment. As most of their fellow-Lutherans in America are German in origin the Texan Wends have gradually become Germanized, although some of them can still speak Wendish.

Isaac Newton. *A Biography. 1642–1727. By Louis T. More. Charles Scribner's Sons, New York.* $4.50. 9 x 6; xii + 675; 1934.

This is not a book to be read hurriedly. Professor More (of the Graduate School of the University of Cincinnati) has gathered within its covers a vast amount of material concerning this great genius, gleaning it from published works, from the great collections of Newton's personal and unpublished papers in the possession of the Countess of Portsmouth and of Viscount Lymington, and from the Newton papers in the University of Cambridge. Without doubt it is the most complete and authoritative record yet to appear. Since the writer has delved so thoroughly into all facts and occurrences which pertained to the development of Newton as scientist, philosopher, politician, financier and theologian, parts of the volume will seem dull to the average reader of biography. Yet for a complete and critical understanding of the life and character of Newton this was necessary. The task of writing the book was doubly difficult by the fact that even before Newton's death he had been exalted into a superman,—"a national momument to the glory of England." The book is thoroughly documented and indexed.

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A Scientist in the Early Republic, Samuel Latham Mitchill, 1764–1831.

By Courtney R. Hall. Columbia University Press, New York. $2.50. 9 x 6; vii + 162; 1934.

A biography that doesn't read like the case history of a psycopathic patient is news. There are no complexes, neuroses, or fixations in this one. Unless maybe Mitchill had a fixation on joining learned societies. He really was the "Fellow of forty-nine societies" as he was reputed to be in a poem by Joseph Rodman Drake. Mitchill was a physician, chemist, geologist, paleontologist, zoologist, botanist, linguist, and poet. He was the founder and editor of the first medical journal in this country. He was a professor at Columbia College, a member of the New York State Legislature, and of both houses of the Federal Congress. He helped clarify the situation in regard to oxidation with which the chemists were struggling, made it possible for Livingston and Fulton to experiment with their steam boat on the internal waters of New York, and he wrote a guide book to New York City. In his rôle as medical man—he was staff physician of the New York Hospital for 20 years—he was particularly interested in all epidemic diseases, both as to treatment and prevention.

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Sterilization? Birth Control? *A Book for Family Welfare and Safety.*

By Helen Macmurchy. The Macmillan Co. of Canada, Toronto. \$1.50. $7\frac{1}{2} \times 5$; 156; 1934.

The book is divided into two parts. The first deals with sterilization and the second with birth control. After giving a summary of the history of the sterilization movement, the author reviews the present status of sterilization in several of the large countries of the world. She makes no particular plea for sterilization of the mentally and physically defective, though realizing the importance of state control, but she feels that segregation is on the whole as effective and makes the patient happier. Her attitude towards birth control is summed up as follows: "Birth Control or contraception is not a normal thing. It should not be undertaken or carried on except for clear, definite or grave reasons, of a medical nature and under medical advice." Nothing very new or original comes out of the book.

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The Quest for Corvo: *An Experiment in Biography.*

By A. J. A. Symons. Macmillan Company, New York. \$2.50. $8\frac{1}{3} \times 6\frac{5}{8}$; xiv + 293; 1934.

Many of the readers of that strange novel *Hadrian the Seventh* must have wondered what manner of man the author was. Mr. Symons not only wondered but resolved to find out and this book is the record of his quest and its results. *Hadrian the Seventh*, it turns out, is in part autobiographical. Not that Rolfe, the self-styled Baron Corvo, was ever elected Pope, but that George Arthur Rose, earning a precarious living by writing, by painting, by photography, persecuted by his fellow Catholics, but firm in his conviction of his vocation for the priesthood, is Rolfe seen through his own eyes. As to the persecutions his acquaintances might have told another story. Rolfe was a true son of the horse-leech, who sucked his victims dry and then apparently quite genuinely felt himself injured because they could no longer afford him sustenance. Friendship with him was "a minor experiment in demonology."

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Iron in the Fire.

By Edgar Morrow. Angus and Robertson, Sydney. 6 shillings. $7\frac{1}{4} \times 4\frac{3}{4}$; ix + 268; 1934.

Advertised as a war book which may be "read aloud in any company," this account of the Australian infantryman is not insipid by any means. It is a chronological account compiled from memory, letters, and what must have been a remarkable diary. There is no attempt at analyzing causes or results of war but the book sticks to the experiences of one common soldier. The "heads" come in for considerable criticism concerning the movement and general management of troops. The really unusual and amazing thing about this book is the way the author makes you feel with him his constantly fluctuating emotions about the war, depending upon how far away the enemy is. When the author is in the line his only thought is to get out as soon as possible, but when he is on leave in England and rather lonely, the war doesn't seem so bad.

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The Family.

By M. F. Nimkoff. Under the Editorship of William F. Ogburn. Houghton Mifflin Co., Boston. \$3.00. $8 \times 5\frac{1}{4}$; x + 526; 1934.

This book is arranged as a text for college use. There are twelve chapters, the first two of which describe in general the nature of the family as a social institution. The following chapters are devoted to the development of the family from early times to the present day. In the light of this history of the changes that have taken place in the family the student is led into the study of the modern American family—its biological, economic, social and personal aspects. The last chapters are concerned with what breaks down family life, and how family guidance clinics can help avert such catastrophes. At the end of each chapter there is a list of selected readings, topics for study and questions for discussion.

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World Civilization.
By Hutton Webster and Edgar B. Wesley. D. C. Heath and Co., Boston. $2.12. 7¾ x 5¼; xxiv + 844 + 18 plates; 1934.

An excellent high school text-book for a one year course in world history. The authors have traced in broad outlines the development of civilization rather than the details of the political history of various countries. In addition to the text the 22 chapters conclude with a suggested glossary, review questions, discussion questions, projects and activities, source readings and selected bibliographies. In a series of appendices are given additional data concerning selected bibliographies and a list of dates and events especially useful for review work and in helping to build the necessary chronological framework. The volume is profusely illustrated and contains a combined index and pronouncing vocabulary.

◆

Petit Historique de l'Affaire de Glozel.
By A. Morlet. G. Desgrandchamps, Paris. 12 francs. 7½ x 4⅝; 207; 1932 (paper).

The author of this book, who first described the archaeologic discoveries (?) made at Glozel, gives his version of that highly odoriferous *affaire*. He states that doubt as to the authenticity of the Glozel findings was inspired by the caretakers of the archaeologic museum at nearby Vichy. They were losing financially from lack of visitors whose interest had shifted to Glozel and the author alleges that they bribed the chief of the French judiciary police to give false evidence of fraud. It is on this man, now dead, that the author vents most of his ire. In the form written, this is not a publication that will add scientific prestige to Dr. Morlet.

◆

Man of Africa.
By Samuel Y. Ntara. Translated and Arranged from the Original Nyanja by T. Cullen Young. Religious Tract Society, London. 3s. 6d. net. 7⅜ x 4¾; 181; 1934.

An anthropologic and psychologic study of the Chewa tribe of Nyasaland, Africa. The author tells his story as a narrative by taking as the subject one Nthondo, of the above tribe, and following his career from birth until pneumonia terminated his tribal chiefship. The book originally appeared in the Nyanja language and has been smoothly translated into English. It gives an interesting, and no doubt authentic, account of the customs of these people. Julian Huxley has contributed a foreword.

◆

One's Company. *A Journey to China.*
By Peter Fleming. Charles Scribner's Sons, New York. $2.75. 8¼ x 5½; 319 + 16 plates; 1934.

Peter Fleming is a young English journalist with a keen sense of humor, remarkable powers of observation and a love of adventure. These qualities combine to make his book most entertaining reading. He travelled across Siberia to Manchuria where he hunted bandits with the Japanese and then went south to the Communist district. His conclusions of a political nature are interesting, but the chief value of the book lies in the picture it gives of the life of the people. The author's photographs which are used as illustrations are excellent, as is the map on which his route is shown.

A History of Marriage and the Family. *Revised Edition.*

By Willystine Goodsell. The Macmillan Co., New York. \$3.50. $7\frac{3}{4}$ x 5; xx + 590; 1934.

A summary of the different marriage and family customs and laws in successive historical periods and those observed in some primitive societies. In particular, the author traces the individual position occupied by father, mother and children in the Hebrew, Greek and Early Roman periods, in the Roman empire and so on up to the twentieth century. The problems resulting from the social conditions of the United States at present are discussed at length.

A list of collateral reading (all in English) is given at the end of each chapter and there are all the requirements sufficient to classify this as a satisfactory textbook.

◆

Vererbungslehre, Rassen-, Bevölkerungs- und Familienkunde. *Für die Abschlussklasse der Mittelstufe höherer Lehranstalten.*

By Albert Bauer. G. Freytag, Leipzig. 1.40 marks. $9\frac{1}{4}$ x $6\frac{1}{4}$; 78 + 2 plates; 1934 (paper).

Believing that the national-socialistic state is built up on a human biological basis, the author is engaged in writing a graded series of books on this subject for use in the schools. The present volume is intended for the intermediate classes of the higher schools, and for those who, having completed their formal education, wish to read up on the subject. As the title indicates the ground covered includes genetics, anthropology, demography, eugenics and methods of collecting genealogical data. There are numerous illustrations and an index.

◆

Story of the Spanish Missions of the Middle Southwest. *Being a Complete Survey of the Missions Founded by Padre Eusebio Francisco Kino in the Seventeenth Century and Later Enlarged and Beautified by the Franciscan Fathers During the Last Part of the Eighteenth Century.*

By Frank C. Lockwood. Fine Arts Press, Santa Ana, Calif. \$4.00 net. $9\frac{3}{4}$ x $6\frac{1}{4}$; vi + 78 + 30 plates; 1934.

Dr. Lockwood has visited each of the missions founded by Father Kino, a Jesuit missionary and explorer of the seventeenth century, in southern Arizona and northern Mexico. In this book he gives their location and history as a supplement to the life of Kino already published. It is written so that it may be used as a guidebook by the tourist, giving distances and directions. There is a good map and lithographed illustrations.

◆

New Sources of Indian History 1850–1891. *The Ghost Dance. The Prairie Sioux. A Miscellany.*

By Stanley Vestal. University of Oklahoma Press, Norman. \$4.00. 9 x 6; xix + 351 + 13 plates; 1934.

This is a collection of source material made by the author while doing research for his biography of Sitting Bull. It includes hitherto unpublished documents setting forth "the views of officials of the Indian Bureau, officers of the United States Army, Sioux Indians, and white citizens" which deal with the Ghost Dance, Sitting Bull and the history of the Sioux Indians. The elaborate table of contents serves as an index and there are maps and illustrations.

◆

The Biology of the Individual. *An Investigation of the Most Recent Advances. The Proceedings of the Association, New York, December 28th and 29th, 1933.*

By Association for Research in Nervous and Mental Disease. Editorial Board: J. Ramsay Hunt, Thomas K. Davis, Angus M. Frantz. The Williams & Wilkins Co., Baltimore. \$6.00. 9 x 6; xv + 323; 1934.

A symposium contributed to by nineteen persons. With one exception, the individual whose biology is considered is human. The exception is introduced by means of a report on breed-crosses of dogs carried on by Stockard and his associates and presented by James. The rest of the papers may be classified roughly as dealing with bodily habitus, growth, endocrines, and more strictly psychological aspects of the individual. There is an index and a list of members.

* * *

A Decade of Progress in Eugenics. *Scientific Papers of the Third International Congress of Eugenics Held at American Museum of Natural History, New York, August 21–23, 1932.*

Committee on Publication: Harry F. Perkins, Chairman; Charles B. Davenport, Ex Officio; Clarence G. Campbell; Madison Grant; Harrison R. Hunt; Frederick Osborn; Paul Popenoe; Laurence H. Snyder; Harry H. Laughlin, Secretary. The Williams & Wilkins Co., Baltimore. $6.00. 9 x 6; xi + 531 + 32 plates; 1934.

This volume consists of an introduction, 65 papers, a description of the exhibits at the Third International Congress of Eugenics, and a list of members. The papers are for the most part extremely short with very few references to the literature. They are grouped into 8 sections drawn from many phases of anthropology, genetics, and eugenics. A considerable number of the papers are reformative in tone but there are a few that are purely objective.

* * *

Körperform, Wesensart und Rasse. *Skizzen zu einer medizinisch-biologischen Konstitutionslehre.*

By Walther Jaensch. Georg Thieme, Leipzig. 4.80 marks. $9\frac{3}{4}$ x $6\frac{3}{4}$; 88; 1934 (paper).

A study of constitutional type and personality, with particular reference to the distinct groups inhabiting Germany. The book is divided into three parts: Race and constitution; Constitutional research and the clinic (in which W. Schulz collaborates with the author); and Outlook on eugenics and race hygiene. This work, like so many of the current German scientific publications, takes on a political tinge, which seems a pity.

Allgemeine Konstitutionslehre in naturwissenschaftlicher und medizinischer Betrachtung. *Zweite Auflage.*

By O. Naegeli. Julius Springer, Berlin. RM. 15 (Paper); 16.20 (Cloth). $9\frac{1}{2}$ x $6\frac{1}{4}$; vii + 190; 1934.

The second edition of this work on Human Constitution amplifies somewhat the contents of the previous edition (reviewed in Volume 3, Number 1 of this Journal) without altering its form or style. One notes especially that the section on genetics has been brought up to date and summarizes very well the more recent observations.

* * *

Hypnotism in the Treatment of Disease: Its Scope. *A Plea for Research.*

By B. Layton Lloyd. John Bale, Sons and Danielsson, London. 3s. 6d. net. $7\frac{1}{4}$ x $4\frac{3}{4}$; v + 44; 1934.

Dr. Lloyd feels that the advantages of hypnosis for anesthesia and for the treatment of functional paralysis and blindness, constipation, insomnia and other conditions are not sufficiently realized by most physicians.

* * *

A Tabular Summary of State Laws Relating to Public Aid to Children in Their Own Homes. *In Effect January 1, 1934. U. S. Department of Labor, Children's Bureau, Chart No. 3.*

Government Printing Office, Washington. 10 cents. $10\frac{1}{4}$ x 8; 40; 1934 (paper).

Student's Study Guide *to Critical Appreciation of the Photoplay Version of Robert Louis Stevenson's Classic of Adventure, Treasure Island.*

Teacher's Key *to Accompany the Student's Guide to Critical Appreciation of the Photoplay Version of Stevenson's Treasure Island.*

By William Lewin. Published for the National Council of Teachers of English. Bureau of Publications, Teachers College, Columbia University, New York. Packets of 30 copies of Student's Study Guide with a key for the teacher, $1.00 per packet. 9 x 6; Guide, 7, Key, 14; 1934 (paper).

UNEMPLOYMENT RESERVES. *Study-Outline. Pertinent Questions. List of References.*
Prepared under the direction of Samuel W. Reyburn, Chairman. Retail Merchants Committee on Unemployment Legislation, 366 Fifth Ave., New York. 8 x $5\frac{3}{8}$; 24; 1934 (paper).

PREHISTORIC ELEMENTS IN OUR HERITAGE. *Bulletin of the John Rylands Library, Vol. 18, No. 2.*
By H. J. Fleure. Manchester University Press, Manchester. 1 shilling net. $10\frac{1}{4}$ x $6\frac{1}{4}$; 36; 1934 (paper).

BIBLIOGRAPHY ON LAND SETTLEMENT *with Particular Reference to Small Holdings and Subsistence Homesteads. U. S. Department of Agriculture Miscellaneous Publication No. 172.*
Compiled by Louise O. Bercaw, A. M. Hannay, and Esther M. Colvin, under the direction of Mary G. Lacy. U. S. Government Printing Office, Washington. 50 cents. $9\frac{1}{8}$ x $5\frac{3}{4}$; iv + 492; 1934 (paper).

ZOÖLOGY

SEA TERNS OR SEA SWALLOWS. *Their Habits, Language, Arrival and Departure.*
By George and Anna Marples. Country Life, London. 15 shillings net. $9\frac{3}{4}$ x $7\frac{1}{8}$; xii + 227 + 58 plates; 1934.

This is a "nature book" that in addition to its beauty and charm makes a contribution of real significance and importance to scientific natural history. Mr. and Mrs. Marples are amateurs, in the sense that they do not get their living by professionally practising zoölogy. But they have developed their hobby in a close and useful alliance with that science. As a result they have attempted in this volume a complete monograph of British Terns, to appeal equally to the nature lover and the scientific man. The result, while not perfect, is extremely good. It embodies great masses of original data based on the authors' own observations on structure, habits, behavior, distribution, etc., and is illustrated profusely with the most beautiful, clear, precise and significant set of photographs we have ever seen of any animal under natural conditions. Their assembling must have cost an infinity of patience as well as technical skill.

The book opens with a detailed historical and systematic account of the species found in Great Britain, and how they may be recognized. Then, after a description of the terneries and distribution of the species among them, follow chapters on arrival and departure, occupation, courtship and marriage, tracks (and the use of track records to build up an understanding of courtship and other behavior that cannot be directly observed because occurring at night—all this reading like an uncommonly good detective story), nests, eggs, and young, food, attacks and defense, panics, experiments, vocabulary, removals and desertions, atmosphere and environment. There is an excellent index, but from a bibliographic viewpoint the book is weak, in a technical professional sense. While the authors evidently know the British literature fairly well, they are not aware of what has been done in other countries. A conspicuous example is found in the absence of any reference to the important observational and experimental work of John B. Watson. But so valuable a book can safely stand on its own positive contributions. Every library of zoölogy and comparative psychology must have this work on its shelves.

* * *

THE RÔLE OF ENVIRONMENT IN THE LIFE OF BIRDS. *Contribution No. 28 from the Baldwin Bird Research Laboratory, No. 449 from the Zoological Laboratory of the University of Illinois.*
By S. Charles Kendeigh. University of Illinois, Urbana. 10 x $6\frac{3}{4}$; 117; 1934 (paper).

In this monograph the author takes the eastern house wren (*Troglodytes a. aedon* Vieillot) as a typical member of the deciduous forest community of the eastern United States and attempts to analyze the reactions of this species to various ecological factors. In other words, the community is studied by learning as much as possible about a common member of that community. Various environmental factors such as temperature, relative humidity, solar radiation, etc., are studied as they affect the migration, distribution, and abundance of the wren. Temperature receives most of the experimental emphasis and, as a result of his experiments, Kendeigh concludes that, for high temperatures, it is the maximum temperature reached during the day which is of greatest ecological importance in the economy of the bird. For low temperatures, the mean night temperature and the duration of darkness are concluded to be the most important.

On the whole, this study is a competent one and should prove a valuable addition to ecological and physiological literature. The author lists a lengthy bibliography and commendably uses it in his text. It is regrettable that the data are not possessed of the usual biometric constants so that sampling errors could be evaluated. It may be that the author took these into account but, if so, his readers have no knowledge of it. In the section dealing with rate of metabolism the reviewer feels the paper would have been strengthened by experimentally determining this rate directly instead of using the loss of weight of the bird as a criterion.

INSECT PHYSIOLOGY.

By V. B. Wigglesworth. Methuen and Co., London. 3s. 6d. net. $6\frac{3}{4} \times 4\frac{1}{4}$; x + 134; 1934.

Here is a welcome and excellent little book on insect physiology. It gives authoritative information about the physiology of the integument, respiration, circulation, digestion, excretion, nutrition and metabolism, reproduction and growth, and nervous functions of insects in general. Practically each fact discussed is accompanied by a specific reference which permits the reader to study further if he so desires—this is an admirable aid. The author has drawn on diverse orders of the insects for his illustrative material so that the volume presents as well-rounded a story as the available data allow. Physiologically-minded biologists, after going through this volume, will feel more than ever that fascinating problems and possible solutions await them in the field of insect physiology.

STUDIES ON SOME PROTOZOAN PARASITES OF FISHES OF ILLINOIS. *Illinois Biological Monographs, Vol. XIII, No. 1.*

By Richard R. Kudo. University of Illinois Press, Urbana. 75 cents. $10\frac{1}{2} \times 7$; 44; 1934 (paper).

This paper is divided into two parts. The first presents the results of a preliminary study of fishes of Illinois belonging to thirty-five species with reference to their protozoan parasites. These fishes belong to thirteen families, of which Catostomidae, Cyprinidae, and Siluridae were found to be common hosts to histozoic protozoan parasites. An unusual case of *Ichthyophthirius* infection in carp is noted. In the second part nineteen new species of Myxosporidia are studied and described, and additional information on four known species of Myxosporidia is given. Included in the paper is a brief bibliography, a group of plates and figures, and an index.

MACROLEPIDOPTERA AND THEIR PARASITES REARED FROM FIELD COLLECTIONS IN THE NORTHEASTERN PART OF THE UNITED STATES. *U. S. Department of Agriculture Miscellaneous Publication No. 188.*

By J. V. Schaffner, Jr., and C. L. Griswold. U. S. Government Printing Office, Washington. 15 cents. $9\frac{1}{8} \times 5\frac{7}{8}$; 160; 1934 (paper).

The present volume is the result of studies begun in 1915 to determine the native hosts of the introduced parasites of the gypsy and brown-tail moths. In addition to information on this point, a good deal was learned about the native Lepidoptera and their parasites. A number of parasitic forms new to science have been found. But most noteworthy is the collection of data which makes possible the listing of the Lepidoptera with their food plants, area of occurrence, information about life cycle, and their parasites. The material is also listed from the opposite point of view—that is, by parasite, with host forms given for each parasite.

LAIKAN. *The Story of a Salmon.*

By Joseph Wenter. Translated from the

German by Charles Ashleigh. Rich and Cowan, London. 6 shillings net. $7\frac{1}{4}$ x $4\frac{7}{8}$; vii + 241; 1934.

A fascinating story of the experiences of a young salmon from the time of his birth to his death twenty years later. The writer draws a romantic picture of the struggles and pleasures of *Laikan* in rivers and pools, his comrades and his enemies, his growing up and journeys to the sea and return to the waters of his birth. A book which will appeal particularly to the young reader of from 12–18 years of age who likes scientific facts diluted with plenty of fiction. The book is without index. Major Josslyn S. Egerton of England contributes a foreword.

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ÜBER DEN GESCHMACKSSINN DER BIENE. *Ein Beitrag zur vergleichenden Physiologie des Geschmacks. Zeitschrift für vergleichende Physiologie, 21. Band, 1. Heft.*

By K. von Frisch. Julius Springer, Berlin. 19.80 marks. $9\frac{1}{2}$ x $6\frac{3}{8}$; 156; 1934 (paper).

The researches indicate that bees can distinguish the tastes of sugar, hydrochloric acid, cooking salt, and quinine. The value of the threshold of taste appears to be influenced by various conditions. Uniformly a 17.1 percent solution of cane sugar is detected by the bees, however, a 8.5 percent solution is detected by only half of the bees, and practically always a 4.25 percent solution is refused. The threshold differs among individual bees, and changes with increase in age so that the taste becomes less keen with advancing age. Finally, as in man there exists the phenomenon of fatigue of taste sense.

◆

ESKIMO YEAR. *A Naturalist's Adventures in the Far North.*

By George M. Sutton. The Macmillan Co., New York. \$3.00. $8\frac{1}{2}$ x $5\frac{3}{4}$; xii + 321 + 12 plates; 1934.

This is an account of the year the author spent on Southampton Island, situated in the mouth of Hudson Bay. It is written chronologically and tells of the life of the people, their games, customs and festivities. The author gets to know many of them well and goes on hunting trips of all kinds. He is particularly interested in the animal and bird life and describes the habits of bears, seals, walrus, foxes, whales, caribou, lemmings and many others. There is a great deal of valuable material in this book, but it could have been made more interesting.

◆

BIOLOGIE DER WASSERINSEKTEN. *Ein Lehr- und Nachschlagebuch über die wichtigsten Ergebnisse der Hydro-Entomologie.*

By H. H. Karny. Fritz Wagner, Vienna. 16 marks. $9\frac{5}{8}$ x $6\frac{5}{8}$; xv + 311; 1934 (paper).

No doubt this book will be welcomed by European limnologists since it gives a good account of the biology, taxonomy, anatomy, and general natural history of many aquatic insects. The volume contains systemic keys which aid the student in determining his specimens, and also many sketches of the forms studied and their habitats. A useful book.

◆

VERTÉBRÉS INFÉRIEURS (*Poissons, Batraciens, Reptiles*). *Actualités Scientifiques et Industrielles 183. Leçons de Zoologie et Biologie Générale VI.*

By Georges Bohn. Hermann et Cie, Paris. 15 francs. 10 x $6\frac{1}{2}$; 96; 1934 (paper).

A not-too-impressive account of the natural history, comparative anatomy, and phyletic relationships of the lower vertebrates—fish, amphibia and reptiles. The material seems too sketchy to be of much use to serious vertebrate students although it might be useful to people interested in a general orientation about these animals.

◆

VON OTTERN UND NATTERN. *Ein Schlangenbuch.*

By Hanns Weltzel. Gustav Wenzel, Braunschweig. RM. 3.50. $8\frac{3}{4}$ x $5\frac{5}{8}$; 148; 1934.

The author, a naturalist and snake-lover, writes charmingly about the natural history of snakes, particularly of the species indigenous to Germany, their care and feeding in captivity, and their treatment in art, lore and modern literature. The book is designed for the layman. The illustrations are well chosen and excellently reproduced.

◆

Veterinary Helminthology and Entomology. *The Diseases of Domesticated Animals Caused by Helminth and Arthropod Parasites.*

By H. O. Mönnig. William Wood and Co., Baltimore. $9.00. $9\frac{1}{4}$ x $6\frac{1}{4}$; xvi + 402; 1934.

An excellent textbook designed for veterinary students and practitioners. The most important parasites of all of the important domesticated animals of all countries are described with illustrations. Descriptions of life cycles are included in practically every case.

◆

The Animal Picture Book.

By H. Mortimer Batten. Thomas Nelson and Sons, New York. $3.00. $10\frac{1}{4}$ x $7\frac{1}{2}$; vi + 129; no date.

Sixty-four very decorative colored pictures with popular descriptions of the habits of the mammals depicted.

◆

An Annotated Bibliography of the Hessian Fly Phytophaga destructor (Say). *U. S. Department of Agriculture Miscellaneous Publication No. 198.*

By J. S. Wade. U. S. Government Printing Office, Washington. 10 cents. $9\frac{1}{8}$ x $5\frac{3}{4}$; 100; 1934 (paper).

BOTANY

The Physiography and Vegetation of Trinidad and Tobago.

By R. C. Marshall. Oxford University Press, New York. $2.25. $10\frac{3}{4}$ x $7\frac{3}{8}$; 56 + 10 plates; 1934.

In the opinion of Mr. Marshall, who is Conservator of Forests on these islands, "there is only one really satisfactory way of assessing the finer divisions of forest types, and that is by the method of strip surveying. In the course of routine departmental work more than 16,000 chains of line have been run during the last few years, all trees half a chain either side of the lines being enumerated by species and girth, and a note taken every chain of the soil down to one foot." The ecological results of this survey are set forth in admirable fashion in the form of descriptions of the various forest types and their successional relationships, maps, floristic lists, and photographs, and these data are accompanied by numerous maps showing the topography, geology and soils, temperature and humidity, and rainfall of the islands. "It is probable that in its virgin conditions, rain forest along with its edaphic climax variations covered over 90 per cent of the colony: to-day the area is between 40 and 50 per cent owing to the clearing of land in the interests of agriculture." One of the interesting features of the book is the argument Marshall advances that land once so cleared may not return to the original type of climax forest but instead may pass through a "deflected succession" to an "entirely different type of vegetation sufficiently stable to be termed a climax." It appears from early records that one such "deflected climax," a type of savannah, has been stable for at least 300 or 400 years.

◆

Contribution à l'Étude des Bactéries Bleues et Violettes.

By Pierre Godfrin. Faculté de Pharmacie de Nancy. 40 francs. $9\frac{3}{4}$ x $6\frac{1}{4}$; xvi + 268 + 10 plates; 1934 (paper).

The results of two years' work in the Department of Bacteriology are here presented to the Faculty of Pharmacy of Nancy as a thesis for the degree of doctor of pharmacy. In a preliminary chapter is outlined the plan adopted by the author for identifying and classifying bacteria in microbiology according to their morphology (by examination in the natural state, including a study of dimensions, motility, form and mode of grouping and natural coloration of the plastids, and examination after staining to show the structure of the plastids); the action of physical, chemical and biologic agents; agglutination; and physico-chemical character of suspensions. Then follow the three main parts of the work: The first describing and classifying, by the previously outlined plan, the bacteria producing blue and violet pigments; the second devoted to the bacterial chromogens; and the third to a discussion of the more important classifications in the literature (which are far from being in accord) and variations in bacteria. There is a bibliography of sixteen pages.

Trees of Trinidad and Tobago.

By R. C. Marshall. Conservator of Forests, Port-of-Spain, Trinidad. 3 shillings. 9 x $5\frac{3}{4}$; x + 101 + 20 plates; 1934 (paper).

This manual was written for the guidance of foresters in Trinidad and Tobago and consists of brief descriptions of the native forest trees.

> In writing descriptions emphasis has been laid on characteristics of bark, leaf and fruit, and the flowers have been relegated to a relatively minor position.
>
> Bark and leaf are the easiest to observe in the forest, and fruits lying on the ground are often the first indication of a given species. Once flowers have fulfilled their function of enabling the species to be botanically identified they often largely lose their interest for the worker in the woods who is more concerned with some factor always to hand.

The Leguminosae have by far the greatest number of species, 57, and the Myrtaceae and Lauraceae come next with 21 and 20, respectively.

There are a number of illustrations, not very well reproduced, and a complete index.

Economic Plants.

By Ernest E. Stanford. D. Appleton-Century Co., New York. $5.00. $8\frac{3}{4}$ x $5\frac{3}{4}$; xxiii + 571; 1934.

This is a valuable reference book as well as an unusually well-written textbook of economic botany. The longest section, 70 pages in length, is devoted to food products, exclusive of vegetables, the only important omission in the book. Nearly as much space is given over to a discussion of the nature, treatment, and uses of wood. The sections on fruits, plants yielding proteinaceous products, textile plants, rubber, and the one dealing with resins, tanning materials, and cork are 30 to 50 pages long. There are 20-page sections dealing with medicinal plants, beverage yielding plants, spices, fixed oils, sugar and sugar plants, and paper and pulp, and a shorter chapter on volatile oils. The author has succeeded very well in emphasizing the items that make the readiest appeal to human interest without sacrificing the botanical significance of the sources of these products and the economic consequences of their use. The illustrations are numerous and well-chosen, and there are numerous maps showing the centers of production of plant products. There is a detailed table of contents and an excellent index.

Handbuch der Ernährung der Landwirtschaftlichen Nutzpflanzen.

By J. Becker-Dillingen. Paul Parey, Berlin. 19.60 marks. $9\frac{1}{2}$ x $6\frac{1}{2}$; viii + 523; 1934.

This treatise on the use of fertilizers in modern agricultural practice is intended for workers in agricultural experiment stations and a number of features make it a useful reference book. After an exposition of the basic principles of plant nutrition and soil science involved, the fertilizer requirements of a large number of field and truck crops are discussed individually, the relevant literature is reviewed, and specific recommendations are made. The illustrations are unusually instructive. Many of them are diagrammatic and illustrate basic principles very effectively. There are sets of excellent colored plates, 11 in all, showing the symptoms of different types of mineral deficiency in oats, sugar beets, potatoes, clover, and tobacco. Graphs showing increase in dry weight, and the amount of mineral nutrients absorbed at different stages in the growth period are provided for a large number of crop plants and are so cleverly done as to invite imitation. A great deal of data on the chemical composition of fertilizers and plant products is presented. There is an index, and bibliographic references appear as footnotes.

L'ÉPIDERME DES GRAMINÉES. *Étude Anatomique et Systématique.*

By Henri Prat. Masson et Cie, Paris. $9\frac{1}{2}$ x $6\frac{1}{2}$; 207 + 4 plates; 1931 (paper).

For purposes of classification the epidermal cell of the Gramineae may be divided into a relatively small number of groups: silico-suberized, exodermic, and homogeneous, and these groups may be further subdivided according to length, waviness of cell wall, and other characteristics. Prat proposes a system of notation for these types and arrives at the conclusion that they constitute a valuable means of distinguishing species in instances where the usual methods of taxonomy give uncertain results. In particular, he treats the species of *Agropyrum* to show how the method can be used for distinguishing species, and the cereal grains to show how the study of epidermal characters can be used to supplement floral analysis.

The book is well illustrated and there is an extensive bibliography but no index. This work originally was published in the *Annales des Sciences Naturelles*.

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DIE PFLANZENGEOGRAPHISCH-ÖKOLOGISCHEN GRUNDLAGEN DES WALDBAUS. *Dritte, völlig umgearbeitete Auflage.*

By K. Rubner. J. Neumann, Neudamm. RM. 36 (bound); RM. 34 (paper). $9\frac{7}{8}$ x $6\frac{7}{8}$; xiv + 597 + 8 maps folded in cover; 1934.

The third, revised edition of this excellent text and reference book is an introduction to the ecological basis on which sound forest management depends, and there is no reason why it should not be as useful to ecologists as it is to foresters for its clear presentation of the fundamentals of plant ecology and for its extensive data on the natural distribution of forest tree species and forest types of Europe.

The first part of the book (about 275 pages) is an analysis of the climatic and edaphic factors that are effective in tree growth, the second part (about 170 pages) deals with the geographic range of forest types in Europe, and the third part (about 200 pages) deals with forests considered as plant communities and the significance of competition. There are numerous well-chosen maps and photographs; bibliographic references appear as footnotes, and there are author and subject indexes.

* * *

L'EMBRYOLOGIE VÉGÉTALE. *Résumé Historique. 1re Époque: Des origines à Hanstein (1870). Actualités Scientifiques et Industrielles 142. Exposés d'Embryologie et de Morphologie Végétales. I.*

By René Souèges. Hermann et Cie, Paris. 12 francs. 10 x $6\frac{1}{2}$; 57; 1934 (paper).

In this important contribution to the history of science Souèges traces the development of the knowledge of the reproduction of plants through three historical periods. In the first one, beginning in antiquity and ending in the last years of the seventeenth century, the concept of sexuality of plants was formulated and established. In the second period, ending about 1822–26, the concept of fertilization developed although it was based largely on macroscopic observation. By the end of the third period, however, just before the epochal discoveries of Hanstein and Strasburger, it was known that the embryo arose from one of the three vesicles which occupy the summit of the embryo sac. All this had to be learned before the study of embryology could begin. Souèges treats the contribution made by individual workers in these three periods adequately, interestingly, and with full documentation. The bibliography covers more than eight pages.

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WILD FLOWERS.

By Homer D. House. The Macmillan Co., New York. $7.50. $11\frac{1}{2}$ x 9; 362 + 264 plates; 1934.

These color photographs of flowering plants are easily the best to be found in any popular botanical book and the color of flowers and foliage is reproduced with remarkable fidelity. These illustrations were first issued by the New York State Museum in an edition that is now exhausted. For each species there is a brief, botanical description and a statement as to its distribution, and for 364 species there are color photographs. There are also a number of black and white photographs. There is a list of illustrations arranged by families, and an index of popular and scientific names of plants.

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La Multiplication Végétative *et le Bourgeonnement chez les Plantes Vasculaires. Actualités Scientifiques et Industrielles 134. Exposés de Biologie Végétale. I.*
By Pierre Chouard. Hermann et Cie, Paris. 10 francs. 10 x 6½; 48; 1934 (paper).

Chouard has undertaken a formal classification of the ways in which plants increase in number without the intervention of the sexual process, illustrating each type by a number of examples, and usually by a drawing. He argues forcibly and plausibly for restriction of the term *reproduction* to sexual multiplication and for restriction of the use of the word *regeneration* to the rare cases in the plant kingdom in which there actually is a replacement of a missing part. There is a good bibliography and a table of contents. It is a valuable contribution to plant morphology.

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Poplars, Principal Tree Willows and Walnuts of the Rocky Mountain Region. *United States Department of Agriculture Technical Bulletin No. 420.*
By George B. Sudworth. U. S. Government Printing Office, Washington. 10 cents. 9 x 5⅞; 111; 1934 (paper).

This work is one of a series of monographs on the systematic dendrology of western trees prepared by the late Mr. Sudworth. For each species of the genera *Populus*, *Salix*, and *Juglans* there is an excellent illustration of flowers and foliage, a distribution map considerably more detailed than any we have seen before, and a thorough description which includes information useful to taxonomists, foresters, and naturalists. There are analytical keys for each genus and there is an extensive bibliography.

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Von der Wildpflanze zur Kulturpflanze. *Die Bedeutung der natürlichen und künstlichen Zuchtwahl für die Entstehung neuer Pflanzenrassen.*
By Hermann Kuckuck. Alfred Metzner, Berlin. 2.80 marks. 8¾ x 5½; 68 + 4 plates; 1934.

This is an interesting delineation of the origin and geographical distribution of some of the commoner cultivated plants, the genetical theories and methods involved in their culture, and problems and objectives of experimental work at the Kaiser-Wilhelm Institute for Plant Breeding. The book is intended for the layman, and the author makes no claim to its being comprehensive.

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Études sur les Mousses de la Région de Montréal. *Contributions du Laboratoire de Botanique de l'Université de Montréal, No. 25.*
By H. Dupret. Institut Botanique Université de Montréal, Montreal, Canada. 75 cents. 9 x 6; 70; 1934 (paper).

Dupret has provided ecological notes for 256 species of mosses found in the region of Montreal. There are drawings to accompany the description of a new species of *Hypnum* and of several new varieties and *formae*, and an excellent index.

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Wheat in Great Britain.
By John Percival. John Percival, Leighton, Shinfield, Reading, Berks. 10s. 6d. net. 8½ x 5½; 125 + 32 plates; 1934.

This volume will serve as an excellent reference to agriculturists. Descriptions and illustrations are given of about fifty different kinds of wheat. There is an interesting historical account of wheat growing from earliest times in Great Britain.

MORPHOLOGY

The Brain as an Organ. *Its Postmortem Study and Interpretation.*
By Frederic Wertham and Florence Wertham. The Macmillan Co., New York. $7.50. 9¼ x 6; xv + 538 + 166 plates; 1934.

Such a long and extremely technical book is not easy reading but this one seems quite considerate of the ultimate consumer. Adolf Meyer in the introduction characterizes the book as follows:

> Anyone who works in the field realizes the great difficulty of rising above mere description and to a constructively critical evaluation of the findings and methods and their interpretation. It is along this line that the present volume takes the lead and is, as far as I can see, of unrivaled value. It brings to the reader a sense for fundamental principles of a sound critical attitude toward general and special pathology.

The authors feel that neuropathologists have become too much dominated by the obviously useful idea of functional localization and that the idea of the brain as an organ and not as something entirely different from any other tissue is a profitable one. There is a long discussion on dissection and histological technique before the chapters on interpretation. The section on "The Extent of the Normal" especially warmed the cockles of this reviewer's heart. There are 160 plates made by Florence Wertham reproduced by the aquatone process. Altogether this is a notable contribution to the literature of neurology.

Our only criticism is that the references to the literature that occur throughout the text are sometimes so incomplete as to make consultation with original sources difficult. There is a list of 117 selected references and an index.

The Anatomy of the Salamander.

By Eric T. B. Francis. With an historical introduction by F. J. Cole. Oxford University Press, New York. $9.00. 9½ x 6¼; xxxi + 381 + 13 plates; 1934.

From the viewpoint of the experimentalist, the comparative anatomist, and the herpetologist the salamander is an important organism. The present volume on its anatomy should find many friends indeed among these folk. It impresses the reviewer as being a very competent and thorough piece of work. The author points out that most of the previous accounts of salamander morphology are replete with errors which have been corrected in this book as much as possible. The presentation of the subject is straightforward and conventional, the various systems being taken up chapter by chapter in the usual way. The book is somewhat novel for including a chapter on the lymphatics—that mysterious system so frequently referred to by comparative anatomists but so infrequently and inadequately dealt with. An admirable appendix completes the book.

The Skeleton of British Neolithic Man, *Including a Comparison with that of Other Prehistoric Periods and More Modern Times.*

By John Cameron. Williams and Norgate, London. 15 shillings net. 8½ x 5½; 272 + 16 plates; 1934.

A systematic compilation of skeletal measurements and anthropometric indices taken from the remains of neolithic man uncovered in England and Scotland. Where it has been possible, the author has compared his results with those obtained from the skeletons of other prehistoric and of more recent periods. He discusses their probable differences in appearance and habits.

Necessarily fragmentary as are the data, yet the author manages to present a clear picture of the changes in the physical aspect of the inhabitants of England and Scotland and their probable racial origin. The many interesting facts which are brought out in this study cannot be mentioned in a brief review. It need only be said that they are useful and necessary for the student of anthropology.

A Textbook of Histology. *Functional Significance of Cells and Intercellular Substances.*

By E. V. Cowdry. Lea and Febiger, Philadelphia. $5.50 net. 10¼ x 6½; 503; 1934.

The author concentrates on building up in the mind of the student a conception of the remarkable integration of the human body. Hence the arrangement of the book is around the blood vascular system—"the great integrator." He states: "the properties of each and every cell in the body are directly dependent upon its heredity, the fluid about it, and the other cells associated with it and should only be investigated in this connection." He strives always to give a conception of cells and elementary tissues in their normal environments. The book is well written, and with much more acumen as to what are really the essentials in the study of histology than most texts on the subject.

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ON THE EARLY DEVELOPMENT OF THE VASCULAR SYSTEM. *The Development of Blood and Blood-Vessels in the Chorion of Man.*
By B. H. Jägerroos. Anatomical Institute of Helsinki, Finland. $9\frac{3}{4}$ x $6\frac{1}{2}$; 86 + 2 plates; 1934 (paper).

This is a further contribution to this subject, based on 25 human abortuses ranging in age from three weeks to three months. The author subscribes to the diphyletic theory of the origin of erythrocytes. On this point as well as on the origin of blood vessels the evidence presented is doubtless as good as can be expected from abortion material dead or moribund an unknown period of time.

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FORMGESTALTUNG IM TIERREICH.
By H. A. Stolte. W. Kohlhammer, Stuttgart. Rm. 1.35. 9 x $5\frac{7}{8}$; 27; 1934 (paper).

The material in this little brochure was presented as a lecture at the University of Tübingen. It deals with the mechanisms involved in early embryological development, and is based on the work of Spemann, Schleip, Mangold and Vogt.

PHYSIOLOGY AND PATHOLOGY

NUTRITION AND DISEASE. *The Interaction of Clinical and Experimental Work.*
By Edward Mellanby. Oliver and Boyd, Edinburgh. 8s. 6d. $8\frac{3}{4}$ x $5\frac{1}{2}$; xix + 171; 1934.

This book, based on the Croonian lectures which the author delivered to the Royal College of Physicians in June, 1933, has for its main thesis the demonstration of the interaction of different experiences in the laboratory and in clinical work in the furthering of medical science. The six sections are as follows: Rickets; dental structure and disease; thyroid gland—simple and toxic goiters; nutrition and infection; nutritional influences on the nervous system— experimental work on animals; extension of experimental results on nerve degeneration to some other clinical conditions.

Summing up the value of combined experimental and clinical work the writer says:

> (1) A clinical post tends to orientate the mind of the laboratory worker towards practical problems of disease, so that a laboratory observation is often interpreted along these lines: (2) It also helps in the interpretation of laboratory results and, by allowing a more comprehensive view of any biological problem, assists in the appraisement of new facts and gives the opportunity of a saner interpretation of new phenomena: (3) a clinical interest suggests new problems for solution in the laboratory: (4) clinical research has in recent years disclosed new chemical agents and new problems of great physiological interest.

On the other hand

> the animal experiments and laboratory remain the points of greatest importance, for it is mainly by means of these that the investigator discovers new phenomena and gets new ideas for clinical trial and application.

The volume is illustrated with photographic plates, figures and contains also tables and graphs. It is well documented but not indexed.

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PERMÉABILITÉ CELLULAIRE ET PROBLÈME DU CANCER.
By W. Kopaczewski. E. Le François, Paris. 40 francs. 10 x $6\frac{1}{2}$; 166; 1934 (paper).

This is an example of rigorous rationalization within the limits of facts. The author critically reviews and synthesizes the results of his experiments and those of many others regarding the structure and nature of the cellular membrane and of the physical and chemical factors in its permeability.

The changes in permeability observed at different stages in the vital cycle of cells lead him to the conclusion that the process of neoformation is accompanied by increased permeability of the membrane and is accompanied by a stabilization of the intercellular and humoral protoplasmic system. From this he is enabled to reach an hypothesis regarding cancer which can be summarized as follows: The greater permeability of new formed cells will permit penetration of foreign substances or an increased quantity of "normal" matter, the cell must therefore increase the speed of its vital cycle; and if such external conditions remain all new cells will continue in this accelerated growth.

At all times the author stresses that this is only an hypothesis, neither final nor all-explaining, but nevertheless justifying more extended experimentation. The author's hypothesis is not original in many of its aspects but he is to be congratulated for the logical manner in which he presents it. The bibliography is excellent.

Physiology in Health and Disease.

By Carl J. Wiggers. Lea and Febiger, Philadelphia. $9.00 net. $9\frac{1}{4}$ x $5\frac{3}{4}$; xxvii + 1156; 1934.

This new textbook of physiology compares very well with the best of the standard textbooks. The author departs from the usual form of didactic exposition in order to satisfy more adequately the needs of the medical students. The usual lengthy discussions on biochemistry, for example, have been curtailed and instead primary importance has been given to the interpretation of disease symptoms in terms of observed experimental findings. The subject matter is presented in orthodox order. The chapters on special senses appear much condensed but this is more than compensated for by an exposition of general systematic physiology, ampler and more detailed than is usually found and which is correlated to specific disease conditions. In particular the sections on Heart and Circulation and on Metabolism and Nutrition deserve special mention. The bibliography is extensive and up to date. There are numerous original charts, graphs and figures which together with the written summaries should enable the student to appreciate intelligently the matter discussed. The author is to be congratulated for he has well achieved his end.

Good Savouries.

By Ambrose Heath. Faber and Faber, London. 2s. 6d. net. $7\frac{1}{2}$ x $4\frac{3}{4}$; 96; 1934.

England's contributions to the world's gastronomic wisdom are neither numerous nor particularly famed. But the notion of a savoury at the end of a dinner was undeniably a smart one, though perhaps not of world-shattering significance. Low cynics of Gallic extraction have even suggested that the real mission of a savoury is, by virtue of its marked and spicy flavor, to overwhelm and nullify any lingering residual taste of a bad dinner. From any such subversive doctrine we formally disassociate ourselves. Savouries *are* good, both in respect of their basic philosophy and their practical effects upon the taste buds; and this little book tells how to make a lot of very good ones. It explores the whole range of possibilities, hot and cold, fish, flesh, fowl, and "warious assorted." We recommend it unreservedly, and particularly to American gastronomisticians, for while it is not a custom with us to *end* a meal with a savoury it is a widespread habit of our perversity to serve precisely these same dishes with our cocktails *before* we set to at serious eating. The book has a detailed classified index.

Amebiasis and Amebic Dysentery.

By Charles F. Craig. Charles C. Thomas, Springfield, Ill. $5.00. 10 x $6\frac{3}{8}$; vii + 315; 1934.

Prepared in answer to the demands of physicians who since the Chicago outbreak of amebiasis in 1933 have felt the need of more knowledge of amebic infection, this monograph surveys all aspects of the subject. On the very first page Dr. Craig emphasizes the fact that the use of the term "amebic dysentery" has been unfortunate, tending to conceal the less violent results of infection with *Endamoeba histolytica*. The result has been that all too often amebiasis has not been diagnosed properly and promptly.

This is a very comprehensive work covering the etiology, epidemiology, pathology, symptomatology, complications and sequelae, diagnosis, and treatment of the two diseases, amebiasis and amebic dysentery. The literature references are very numerous and given with each chapter, besides which there is an author index as well as a subject index.

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Handbuch der biologischen Arbeitsmethoden. *Lieferung 433*. Containing following articles: *Die Methoden der Fluoreszenzmikroskopie*, by Max Haitinger; *Elektrokapillarität*, by Marie Wreschner.
Urban und Schwarzenberg, Berlin. 5.60 marks. 10 x 7; 93 + 1 plate; 1934 (paper).

In the first article two methods for the study of animal and plant preparations under the fluorescence microscope are recommended; direct observation of fluorescence, and observation of microscopic preparations previously treated with solutions of fluorescent substances, the latter method being analogous to the usual histological staining techniques, and differing from them in that the preparation is irradiated with ultraviolet light and the light of the visual range is emitted from certain structures. This method is said to require very little time.

The second paper is a thorough discussion of electro-capillarity and its use in the measurement of electric currents as small as 10^{-3} to 10^{-5} volts such as are encountered in the measurement of nerve and muscle action currents. Various types of electrometers are described and explicit instructions are given for their construction and operation, and for the interpretation of results obtained by their use in physiological experiments.

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Auditory Acuity of Monkeys. *Comparative Psychology Monographs, Vol. 10, No. 3, Serial No. 49.*
By G. R. Wendt. The Johns Hopkins Press, Baltimore. 75 cents. 10 x $6\frac{7}{8}$; 51; 1934 (paper).

This is a report on an investigation of the auditory acuity of 11 monkeys. The method, apparatus and training of the animals are described in detail and it appears that the experiments have been conducted with due care and thoroughness. The author observes striking similarity between his results and those obtained on chimpanzees by Elder. Comparing the auditory acuity of the monkeys and of 5 young adults tested with the same apparatus it is to be seen that there is very little difference except for the response to 4096 d.v. For this frequency the monkeys show marked impairment. It may be added that this 4096 "dip" has also been observed in humans and is typical in males between 30 and 50 years of age.

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The Physical and Mental Growth of Prematurely Born Children.
By Julius H. Hess, George J. Mohr, and Phyllis F. Bartelme. The University of Chicago Press, Chicago. $5.00. 9 x 6; xxiii + 449; 1934.

The clinical data collected on some 1900 premature infants are summarized and analysed in this monograph. The senior author, noted in the field of pediatrics, describes in some detail methods, nursing care, and apparatus used in his clinic and discusses the causes of prematurity as well as the mortality in this group, presenting some very interesting statistics. The junior authors report on the development of the surviving infants which they compare with that of the normal siblings. It is found, for example, that there is very little difference between the two groups with respect to mental development and susceptibility to childhood infections. On the other hand it appears that increase of height and weight is a function of weight at birth.

The many other observations regarding specific clinical problems together with those mentioned render this book invaluable for physicians, psychologists, anthropologists, etc.

Clinical, Pathogenetic and Experimental Investigations of Endometriosis, *Especially Regarding the Localisation in the Abdominal Wall (Laparotomy Scars) with a Contribution to the Study of Experimental Transplantation of Endometrium.*

By Hans F. Harbitz. P. A. Nordstedt & Søner, Stockholm. 10 Swedish crowns. $9\frac{1}{8}$ x $5\frac{3}{4}$; xi + 400; 1934 (paper).

This is a comprehensive monograph on the clinical and experimental aspects of transplanted uterine mucosal membrane growing in the abdominal cavity or in incision scars following abdominal operations. Part 1 deals with ectopic endometrium and the theories that attempt to explain how it reached the site of its development: the "embryological rest" theory, the tubal regurgitation theory of Sampson, and others. Part 2 deals with the accidentally seeded bits of endometrium along the track of the surgeon's knife, as for example at Caesarean sections. Part 3 is experimental, the rabbit serving as subject in intentional transplants of the endometrium and the study of their fate. The literature of Part 2 is the only portion of the extensive literature which the author considers relatively complete. The book is illustrated.

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La Sensibilité Réflexogène des Vaisseaux aux Excitants Chimiques. *Actualités Scientifiques et Industrielles 180. Exposés de Biologie Générale en rapport avec la Cytologie III.*

By C. Heymans and J. J. Bouckaert. Hermann et Cie, Paris. 9 francs. 10 x $6\frac{1}{2}$; 33; 1934 (paper).

It has long been known that the pressure and chemical composition of the blood affect the respiratory, vasomotor and cardio-regulatory centers but it has not been so clear whether the influence is direct or reflex. As a result of their many ingenious experiments the authors conclude that within physiological limits the centers are not directly affected, but that the cardio-aortic and sino-carotid vasosensory zones are the starting-point of respiratory, vasomotor and cardiac reflexes. In the sino-carotid region the sensitivity to pressure is localized in the vascular wall of the carotid bifurcation, while sensitivity to chemical excitants seems to be situated in the glomus caroticum.

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Endogene Faktoren in der Tumorgenese *und der heutige Stand der Versuche einer biologischen Therapie.*

By G. Fichera. Julius Springer, Berlin. 7.50 marks. 10 x $6\frac{3}{4}$; 83; 1934 (paper).

This is a summary, translated from the Italian, of the work of members and students of the Victor Emmanuel III National Institute for the Study and Cure of Cancer, of which the author is director. It is based on the possibility of utilizing extracts of various organs, particularly the spleen, lymph glands and bone marrow, in the treatment of malignant tumors, either alone or in conjunction with irradiation and surgical procedures. Both experimental and clinical data are presented. There are two bibliographies—one confined to publications by members of the Institute, and the other to the works of others published between 1911 and 1933.

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Physiopathologie des Traversées Chimiques et Bactériennes dans l'Organisme.

By Noël Fiessinger. Masson et Cie, Paris. 45 francs. 9 x 6; 370; 1934 (paper).

This is a series of lectures delivered to medical students on the penetration of foreign substances into the human body and the physiological and pathological reactions involved. The clinical significance of a number of kinds of disorders due to deficient or excessive penetration of materials is fully discussed and there are notes on the appropriate therapeutic treatment. The author apparently believes in extracting the maximum of inferences from the minimum of data and in his interpretations he has been greatly influenced by very recent French work. The work is equipped with a list of authors, but no further bibliographical references.

KREBS *im Lichte biologischer und vergleichend anatomischer Forschung. II. Band, 1. Heft: Albuminoide, Schilddrüse, Kropf, Hypophyse, Eierstock, Adenosis.*
By Josef Lartschneider. Franz Deuticke, Leipzig and Vienna. 5 marks (Germany); 7.50 schilling (Austria). $7\frac{3}{4}$ x $5\frac{1}{2}$; 94; 1934 (paper).

The second number of a series of books intended by the author to revolutionize the current concepts of the etiology of cancer. He approaches the problem from the point of view of the normal behavior, organization and productive behavior of the organs involved—in this case, the glands of inner secretions. The conclusions are derived not from original methods and work of his own but by giving different interpretations to the histological preparations of other investigators. The work is illustrated, indexed and provided with a bibliography. We doubt that the author's hopes will be realized on the basis of this book.

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AN INTRODUCTION TO HUMAN PHYSIOLOGY.
By Lathan A. Crandall. W. B. Saunders Co., Philadelphia. \$2.00 net. $7\frac{5}{8}$ x $5\frac{1}{4}$; 325; 1934.

A text on organ and system physiology which should prove valuable to those individuals interested in getting an accurate and moderately comprehensive survey, in some 300 pages, of the workings of the human body. The book is well written and the subject matter seems to have been competently combed so as to include the more important facts and to exclude more detailed data. The material is organized along conventional lines with the various systems taken up by chapters.

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THE SPAN OF LIFE *as Influenced by the Heart, the Kidneys and the Blood Vessels.*
By Franklin R. Nuzum. Charles C Thomas, Springfield, Ill. \$2.00. $9\frac{1}{8}$ x 6; ix + 108; 1934.

This book is a summary of lectures given before a lay audience with the purpose of describing the functions of the heart, blood vessels and kidneys, showing how and why the structures of these tissues change, and how such changes may be prevented or treated. It is a very clear, understandable, and generally excellent exposition with several fine diagrams. There is a brief index.

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A COLLEGE TEXTBOOK OF HYGIENE. *Revised Edition.*
By Dean F. Smiley and Adrian G. Gould. The Macmillan Co., New York. \$2.00. $8\frac{3}{4}$ x $5\frac{1}{4}$; xvii + 383; 1934.
COMMUNITY HYGIENE. *Revised Edition.*
By Dean F. Smiley and Adrian G. Gould. The Macmillan Co., New York. \$2.00.

The earlier editions of these two textbooks were reviewed in Volume 3, page 590 and Volume 4, page 573, respectively. In general, the style, point of view, and topics considered are the same in the two editions, but both books have been quite completely rewritten incorporating new contributions to knowledge. To be recommended as excellent texts.

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POULTRY AILMENTS *for Poultry-keepers, Veterinary, Agricultural and Poultry Students.*
By W. P. Blount. Poultry World, London. 5 shillings net. $7\frac{1}{4}$ x $4\frac{7}{8}$; x + 306; no date.

This book, designed for the lay reader as well as veterinary, agricultural and poultry students, contains a minimum of technical language. The author, through his wide experience in poultry research and veterinary laboratories in England, has been able to produce an excellent handy volume for poultry keepers. The work is well illustrated and contains a glossary and index.

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VITA PIÙ SANA E PIÙ LUNGA. *Libro d'igiene dedicato alle persone colte.*
By Emilio J. Pampana. Edizioni "Annali d'Igiene," Rome. 12 lire. $8\frac{1}{2}$ x $5\frac{1}{2}$; 114; 1934 (paper).

This booklet rationally advises the layman in matters of personal hygiene, diet, etc.

It is well written and at no time does the author become pedantic or transcend well established physiologic facts.

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Problèmes de l'Hygiène Alimentaire. *Actualités Scientifiques et Industrielles 186.*
By J. A. de Loureiro. Hermann et Cie, Paris. 8 francs. 10 x $6\frac{1}{2}$; 28; 1934 (paper).

This little book gives an excellent summary of our present knowledge of nutrition. There is a bibliography of four pages.

BIOCHEMISTRY

An Introduction to Plant Biochemistry.
By Catherine C. Steele. G. Bell and Sons, London. 15 shillings net. $8\frac{5}{8}$ x $5\frac{1}{2}$; viii + 356; 1934.

The purpose of this book is to "provide students of Botany with an introductory account of the chemical nature and relationships of the substances elaborated by plants," and this is accomplished in a very satisfactory manner. Biochemically important substances are arranged and discussed according to their chemical composition, and toward the back of the book are seven chapters on "Plant Metabolism," dealing more specifically with chemical physiology, particularly with enzymes, nitrogen metabolism, and respiration. In the text at appropriate places are directions for laboratory experiments, many of them of a quantitative nature. The book is written for botany students with a little background in organic chemistry, and is well suited to their needs. The bibliographies are short and are limited, for the most part to reference books, and there are two excellent indexes, one for botanical names, and another general index.

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Les Caroténoides des Plantes. *Actualités Scientifiques et Industrielles 137. Exposés de Chimie Biologique. I.*
By Edgar Lederer. Hermann et Cie, Paris. 18 francs. 10 x $6\frac{1}{2}$; 83; 1934 (paper).

This is an excellent review of work on the chemical constitution and properties of carotin and related compounds. Although their chemical status has been fairly well defined by important work done since about 1928 the biological rôle of these important substances is still a matter of conjecture. It has been assumed by all workers in the field that carotin plays some part in photosynthesis and it is known that mammals can transform carotin into vitamin A but the exact mechanisms of these processes are still unknown. The reviewer has done this work very capably and this booklet belongs in every biological and biochemical library. There is a bibliography of 200 titles and an index.

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Carotinoide. *Ein biochemischer Bericht über pflanzliche und tierische Polyenfarbstoffe.*
By L. Zechmeister. Julius Springer, Berlin. 28 marks (paper); 29.40 marks (cloth). $8\frac{5}{8}$ x $5\frac{1}{2}$; xii + 338; 1934.

In this monograph is recorded the present day chemical knowledge concerning the carotinoids. It gives a detailed account of the structure of the individual forms, their distribution and physiological rôle in plants and animals, their relation to terpenes, sterines, vitamin A, lipoids and albumin, and methods of their determination. This is an important book, written by an authority who has himself contributed much to the sensational progress during the last decade in this field of organic chemistry. The bibliography appears to be complete and the index is adequate.

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The Carbohydrates. *Fifth Edition.*
By E. F. and K. F. Armstrong. Longmans, Green and Co., New York. \$6.50. $9\frac{1}{2}$ x 6; vii + 252; 1934.

This is the fifth edition of a standard biochemical reference book which has been completely rewritten since its last appearance. In the meantime the section on the glycosides has been split off and issued as a separate volume. The authors regard Haworth's formulae for the two ring forms of glucose as firmly established and the formulae for di- and polysaccharides have been modified accordingly. The book is written for biochemists and biologists rather than for organic chemists. There is a good index and brief bibliographies are appended to each chapter.

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Analyse des Mécanismes Chimiques chez les Êtres Vivants. *Actualités Scientifiques et Industrielles 165.*
By Théophile Cahn. Hermann et Cie, Paris. 8 francs. 10 x $6\frac{1}{2}$; 26; 1934 (paper).

This essay deals tediously and verbosely with some of the more self-evident principles of chemical physiology, especially the precautions necessary in interpreting the results of chemical analyses. Cahn's principal concern is with co-ferments and the only conclusion he reaches that seems to be at all new is that the study of co-ferments will "indicate the nature and importance of the different chains of reactions in tissues."

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Vitamine und Blut. *Ein Beitrag zur klinischen Bedeutung der Retikulocyten.*
By Richard Seyderhelm and Hermann Grebe. Johann Ambrosius Barth, Leipzig. 2.70 marks. 9 x 6; 42; 1935 (paper).

The authors claim to have discovered a relationship between vitamins and reticulocytes in the blood and bone marrow. After an introduction on the general clinical significance of increase of reticulocytes, the authors describe experiments showing that following the intake of certain vitamins, particularly B_2, C and D, the number of reticulocytes increased. Both commercial preparations and vitamin-rich foods were used.

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Handbook of Chemistry. *A Reference Volume for All Requiring Ready Access to Chemical and Physical Data Used in Laboratory Work and Manufacturing.*
Compiled and Edited by Norbert A. Lange, assisted by Gordon M. Forker, with An Appendix of Mathematical Tables and Formulas by Richard S. Burington. Handbook Publishers, Sandusky, Ohio. $6.00. $7\frac{3}{4}$ x $5\frac{1}{4}$; xiv + 1545; 1934.

This is one of the most useful compendia of chemical, physical, and mathematical data available at present. Its compiler, Professor Lange, has had long experience in preparing handbooks of this sort, and this volume includes an unusual variety of tables, including more data on biochemistry than most books of this kind. The book is very attractively printed in type that resembles the lettering of a draughtsman and that adds greatly to the legibility of the tables.

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Die Hormonforschung und ihre Methoden.
By Max Reiss. Urban und Schwarzenberg, Berlin. 15 marks. $8\frac{3}{4}$ x 6; xii + 415; 1934 (paper).

Reiss brings together here the present knowledge concerning the physiology, chemistry, and pharmacology of the hormones, together with methods for their extraction and study employed by various investigators. Several chapters on insulin are included. Each section is supplied with a bibliography and the book is indexed.

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Fortschritte der Physiologischen Chemie 1929–1934.
By various authors. Verlag Chemie, Berlin. 4.40 marks. 9 x 6; 311 + 1 folding table; 1934 (paper).

Nineteen authorities in their respective specialties contribute chapters to this survey of the advances in physiological chemistry during the past six years. The book is divided into four sections: natural elements, enzymes, vitamins and hormones. Each chapter is well documented. There is no index.

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Die Dreikohlenstoff-zucker und ihre biologische Bedeutung. *Sammlung chem-*

ischer und chemisch-technischer Vorträge Neue Folge Heft 23.
By Herbert Appel. Ferdinand Enke, Stuttgart. 3.20 marks. 9¾ x 6½; 40; 1934 (paper).

The essentials of the chemistry of the triosens and their compounds, alcoholic fermentation, and glycolysis, presented in a handy form for the use of biologists.

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BIOCHEMICAL AND ALLIED RESEARCH IN INDIA IN 1933.
Society of Biological Chemists, Indian Institute of Science, Bangalore. Subscription Rs. 2 per year. 8½ x 5½; 81; 1934 (paper).

SEX

WOMAN *as a Sexual Criminal.*
By Erich Wulffen. Translated into English by David Berger. American Ethnological Press, New York. $6.00. 9¼ x 6; 528 + 7 plates; 1934.

A more accurate title for this book would be "Women in Court" for the individual case histories are taken almost exclusively from police records, and because Wulffen has used an odd sort of definition of sexual crimes.

> Most of woman's criminal tendencies, on account of close-lying psycho-physiological causes, stand in some fixed relation to her sex life. In this sense then the female thief, swindler, extortioner, incendiary, robber, murderer, may be regarded as a sexual criminal. This imputation is so lucid and so easy to understand that its adoption bids fair to become current.

Wulffen is a misogynist, full of bilious generalizations.

> "The normal human predisposition induces man to crime." "The instinct of cruelty, typified in the animal, is more easily and severely aroused in woman because she is more intimately tied-up with nature than man, because her organization is more primitive and because her instincts have a freer play." "Just as she lacks a strictly objective sense for justice and truth, so she is also deficient in observing the law which she breaks in opposition to the supreme power and to the police; nor has she a marked sense for the rights of property. This is evinced by the innumerable shop and store thefts, perpetrated almost exclusively by women old and young."

The author has a confidence we do not share in his ability to decide just what actions are instinctive, or due to predisposition. The unkindest thing that can be said about the book, however, is that Wulffen conspicuously failed to heed his own admonition (p. 72). "It must be repeated that our own 'male' experience of sex may perhaps impute to woman traits which she does not possess. In view of the fact that modern thought has increasingly encouraged our doubts in the objectivity of knowledge it would not be amiss to approach our problem with great caution."

* * *

RHYTHM OF LIFE. *A Guide to Sexual Harmony for Women.*
By Sofie Lazarsfeld. Translated by Karsten and E. Pelham Stapelfeldt. Greenberg, New York. $5.00. 8 x 5½; xv + 329 + 12 plates; 1934.

In the Introduction the author tells us why the book is necessary: There are man-made books on the subject of the sex life that give man's condescending viewpoints without much bother about that of woman; and there are women authors who write with a touch of bitterness against man in "an over-compensation which is the result of the enforced second-rate state of womanhood." Throughout the work are many astute analyses of the human male from the standpoint of the school of Alfred Adler, founder of the Vienna bureau for advice on the problems of life (including marriage, of course). It is from this "school in the art of living" that the author gets much of her raw material, case histories. Hence the book is greatly colored by the Adlerian philosophy of the inferiority complex. While the book seems much padded, it reads fluently and is punctuated with sound advice based on wide and keen insight into human nature.

* * *

NATURE'S WAY. *The Fertile and Sterile Periods of Marriage.*
By Victor C. Pedersen. G. P. Putnam's

Sons, New York. $1.00. 7 x 4½; ix + 81; 1934.

In the author's foreword to this little book we read the following: "This book is dedicated to those men and women who regard parentage as the noblest purpose of life, but who further regard the spacing of children as of immeasurable importance." It "will appeal to those men and women who honor nature's laws and refuse the unseemly practices of artificial means." Considerable information is given about the physiology of women and particularly of the monthly cycle and the works of Knaus and Ogino on the days in the month of probable conception and sterility. The author seems very sure of the value of his method for birth control, but in the concluding chapter he states that it is not proved beyond all doubt—only beyond all reasonable doubt. A lengthy literature list is given but the volume is without index.

* * *

MARRIAGE HYGIENE, *Volume I, Number 1. Edited by A. P. Pillay. The Times of India Press, Bombay.* 18 s. or 10 Rs. per volume of 4 numbers; 4 s. 6 d. or 2/8 Rs., single copy. 9¾ x 6; iv + 111; 1934.

A new journal published in India is hereby launched. The aims of the magazine as expressed by the editors are:

> 1. To secure for the science of conjugal hygiene a proper place in preventive medicine by persistently setting forth the importance of this subject and its interactions on the personal, domestic, and social life and happiness of nations.
>
> 2. To publish contributions which are believed to be necessary for scientific sane sex teaching, with an outlook on physiology rather than on pathology, on normal functions of life rather than on the abnormal.
>
> 3. To bind its readers together into a brotherhood of clean thinkers and bold fighters against prejudice, evasion, and meaningless taboos.

* * *

HOMOSEXUALISMO CREADOR.
By Nin Frias. Javier Morata, Madrid. 25 pesetas. 9½ x 6½; 383 + 12 plates; 1933 (paper).

This is a glowing apology for homosexuality which the author seems to regard as the real essence and cause of greatness in art, philosophy, and even civil and military leadership. There is practically no famous historical figure which he does not classify as homosexual, either openly or by innuendo. This is possible by using the term homosexuality to cover any form of friendship between men. The purpose of the book is to demonstrate that since all the great men mentioned were homosexually inclined (*sic*), society would gain immensely by tolerating homosexuality. There is no apparent order in the exposition of the material, nor proof of many assertions or of the conclusions. In general, it reads like a mediocre history of art for college students.

* * *

BIRTH CONTROL. *Its Use and Misuse. By Dorothy D. Bromley. Harper and Bros., New York.* $2.50. 7¼ x 5; xxii + 304; 1934.

Amid the flood of pompous and lurid sex books of the day comes this unsensational volume by Mrs. Bromley—accurate, informative, easily understood. The author, herself a layman, has digested the scientific literature bearing on the subject which she summarizes fairly and without bias. She has, moreover, had the best personal advice in the preparation of the volume.

The book is more than the usual rule-of-thumb catalogue of methods and brands. A background is first laid of a discussion of the medical and sociological justification of, and demand for contraception. Furthermore, each method whether surgical, biological, chemical or mechanical, is discussed in relation to ascertained facts that form the theoretical basis for a given method. Authorities are amply cited.

* * *

THE RIGHT USE OF SEX *for Best Health and Happiness in Marriage.*
Emerson Books, New York. 10 cents. 9 x 6; 4; 1934 (paper).

This leaflet of four pages (two leaves) is by all odds the best thing that we have seen to put in the hands of your children when they are getting ready to be married, and have become fully conscious that sex presents a personal problem to them. It is fine, and clean, and sound, and its brevity leaves no room for drivel. It is anonymously produced, but we can assure our readers that one of those responsible for its preparation is a wise and distinguished professional zoologist.

◆

Sex-Hygiene. *What to Teach and How to Teach It.*
By Alfred Worcester. Charles C Thomas, Springfield, Ill. $2.50. 9 x 6; ix + 134; 1934.

The author has had wide experience in lecturing on sex hygiene before medical groups, students, etc. and in this book he presents a useful guide for physicians, teachers, clergymen, and parents in dealing with problems of sexuality. The volume is indexed.

◆

Marriage and Sexual Harmony.
By Oliver M. Butterfield. Emerson Books, New York. 50 cents. 8½ x 5½; 40; 1934 (paper).

Another of the ever-increasing instruction books on the sex technique. This small volume has in condensed form about all the information usually presented in larger works on the same subject. Its inexpensiveness should help to increase its popularity.

◆

BIOMETRY

Das Wachstum der Körperlänge des Menschen. *Kungl. Svenska Vetenskapsakademiens Handlingar, Tredje Serien, Band 14, No. 1.*
By Gaston Backman. Almquist and Wiksells, Stockholm. Swed. cr. 7. 11 x 7¾; 145; 1934 (paper).

The author presents an interesting if not entirely original method of analysing growth curves of height. Assuming that the curve is a compound one he divides it into three component curves, each of which he fits by a logarithmic function. The three component curves are supposed to represent the impetus to grow in height that the organism receives respectively at the primordial cell stage, in infancy and at puberty. The variable used in the calculation is the ratio between the heights in two successive years. And here are included 35 sets of calculated ratios resulting from different types of growth curves. These have been applied to 209 series of height measurements collected from the literature, and both theoretical and observed values are reported. The author discusses the different form of growth in well-to-do and poor, dwarfs and giants, in relation to which of the component curves it affects, and also the effect on the latter of the change in function of the endocrine glands. While this represents an important contribution it must not be forgotten that curve fitting is always an empirical process and that other forms of statistical analysis may well give the same agreement between theoretical and observed values.

◆

The Principles of Logic. *An Introductory Survey.*
By C. A. Mace. Longmans, Green and Co., New York. $4.50. 8⅝ x 5½; xiii + 388; 1933.

This excellent textbook is intended to provide for the student who is not specializing in logic "a rapid survey of the subject, to indicate some of the points of view from which it may be studied, to outline what is fairly stable in its systematic doctrine and to introduce its problems." It contains an outline of the traditional Aristotelian logic, an introduction to "symbolic" logic—a term which the author considers unfortunate—the development of the theory of classification into the theory of statistics and probability, and a treatment of inductive inference and scientific method. Annotated bibliographies are given at the end of each chapter. There is an index.

◆

Statistical Methods for Research Workers. *Fifth Edition—Revised and Enlarged.*
By R. A. Fisher. Oliver and Boyd,

Edinburgh. 15 shillings net. 8¾ x 5½; xiii + 319 + 6 folding tables; 1934.

In the fifth edition of this well known textbook, earlier editions of which have been noted in Vol. 1, page 309, and Vol. 8, pages 238–239, the section on the analysis of covariance has been further enlarged and sections have been added on Yates' correction for continuity in the distribution of χ^2, the exact test of significance for 2 × 2 tables, and the adjustments to be made in a regression equation when it is decided to omit one or more of the variates. A bibliography and an index are provided.

* * *

MASS UND ZAHL IM ZELLLEBEN.
By K. A. Heiberg. Levin und Munksgaard, Copenhagen. Dan. Kr. 2. 9 x 6; 32; 1934 (paper).

A morphological study of the differences in cell size, number and quality in several organs and tissues under normal and abnormal conditions. The sections of the book deal with: the hypophysis during pregnancy; the suprarenal gland as affected by tumor of the kidneys; the pancreas of diabetics; erythroblasts; lymphocytes during leukemia, mycosis fungoides and other disorders. Some of the dimensional findings are tabulated.

* * *

THÉORIE ANALYTIQUE DES ASSOCIATIONS BIOLOGIQUES. *Première Partie: Principes. Actualités Scientifiques et Industrielles 187. Exposés de Biométrie et de Statistique Biologique IV.*
By Alfred J. Lotka. Hermann et Cie, Paris. 14 francs. 10 x 6½; 45; 1934.

In this book Dr. Lotka presents to the French reader some of the concepts and results—such as evolution as the development of a system of interacting species rather than of a single species and the functional equations which describe this development—which are already familiar to English and American readers from his well known *Elements of Physical Biology.*

* * *

ZUR BERECHNUNG DES STATISTISCHEN MITTLEREN FEHLERS (STANDARD ERROR). *Formeln und Tabellen, Welche die Bestimmung des in der Wahrscheinlichkeitsrechnung angewandten mittleren Fehlers Erleichtern. Acta Societatis Medicorum Fennicæ "Duodecim," Ser. B., Tom. XIX, Fasc. 2.*
By A. M. Ritala. Universitäts-Frauenklinik in Helsinki, Helsingfors. 9¾ x 6½; 85; 1933 (paper).

Tables of $\sqrt{\frac{pq}{n}}$, of $\sqrt{\epsilon^2(p_1) + \epsilon^2(p_2)}$ and of $\frac{1}{\sqrt{n}}$ for use in calculating standard errors.

PSYCHOLOGY AND BEHAVIOR

INFANT BEHAVIOR. *Its Genesis and Growth. By Arnold Gesell and Helen Thompson, assisted by Catherine S. Amatruda. McGraw-Hill Book Co., New York.* $3.00. 9 x 5¾; viii + 343; 1934.

A study of developmental behavior in infants under one year by a well-known investigator of child psychology. Chapter three (pp. 44–267) constitutes the main part of the book, and summarizes the observed behavior patterns shown in 25 different situations, for 15 different age levels from 4–56 weeks. Some of the behavior characteristics studied related to posture and locomotion, but for the most part the authors concerned themselves with observations on prehension and manipulation behavior—(i.e. dangling ring behavior, rattle behavior, single and massed cubes behavior, tower building behavior, pellet behavior, bell behavior, ring and string behavior, etc.). Chapter four deals with the ontogenetic patterning of infant behavior. For purposes of clarity the authors divide the developmental periods into three prenatal periods and six postnatal periods which carry the child from time of conception up to its first birthday. They then consider four distinguishable spheres of behavior: (1) posture and locomotion, (2) prehension and manipulation, (3) perceptual and adaptive behavior, (4) social and language behavior, and relate them in so far as is possible to the nine various age levels. For purposes of orientation this chapter should be read first. Chapter five deals with the rôle of maturation in the patterning of behavior, and chapter six with the possibilities and limitation of developmental diagnosis of infant behavior. Except for minutiae of the tables and the rather long and complicated account of behavior items, this book is extremely enjoyable and profitable reading, besides being a thoroughly sound and scholarly work.

* * *

Individual Psychology and Sexual Difficulties (II).

By Alfred Adler and F. G. Crookshank. The C. W. Daniel Co., London. 2s. 6d. net. $8\frac{1}{2}$ x $5\frac{1}{2}$; 55; 1934 (paper).

The Medical Society of Individual Psychology (abbreviated to I.P.) is a British organization that, collectively, follows as a disciple the leadership of Dr. Alfred Adler. Its biological philosophy is perhaps fairly indicated in the following quotation from a lecture by Dr. Adler, with which the present volume opens.

> Left-handedness is inherited, but the results are the results of *use*. Therefore consider what I always say: Inherited abilities and disabilities, environmental influences are only the *bricks*. You cannot know what this child will build up. You can influence the child, but the child is free in the use of these bricks and therefore you cannot predict, but you can see what the child produces, how he uses his inheritance and his environmental influences. At this point I want to say something about the accusation made by critics and revilers of I.P.—that I.P. overlooks inheritance. That is ridiculous, because I started with inheritance, but I regard it in the right place, as the bricks. Others say that I.P. is a teaching of environment. That is also ridiculous, because it omits what is the most important part of I.P., how the child uses these bricks. The answer is that you find children with great deficiencies who develop well, and others with little deficiencies who develop badly. You find millions of varieties. Talking of the deficiency does not give you any hint what the child will do.

The society issues pamphlets in a regular quarterly series, of which this is one. Besides the general lecture by Dr. Adler from which we have quoted, he contributes another paper on Sexual Perversions. The late and lamented Dr. F. G. Crookshank has a paper on Individual Psychology and Sex. The remainder of the volume is made up of news, notes and announcements.

* * *

Mental Defect.

By Lionel S. Penrose. Farrar and Rinehart, New York. \$2.50. $8\frac{1}{8}$ x $5\frac{1}{4}$; xi + 205; 1934.

An extremely readable exposition of the status of the study of feeble-mindedness. The purpose seems to be not so much the introduction of new data as the synthesis and correlation of existing information on many phases of the subject. The author emphasizes the necessity of interpreting results in the light of the unconscious selection of material. One example of such selection is that the institutionalized feeble-minded will usually come from the lower social classes where the environment may be very unfavorable. Also, the author points out that family pedigrees are practically never published except when some defect is apparently inherited so that we have neither a normal population nor one showing isolated cases of the defect with which to compare. Another variable often not sufficiently considered is the variation in all laboratory tests, including the Wassermann. Penrose's discussion of this point is very good.

Some rather fancy statistics are introduced by the author. Sometimes the reasons for departing from the conventional statistical procedures are not very clear, and far-reaching results are determined from inadequate samples.

The chapter on "Treatment in the United States" added by the American publishers does not come up to Dr. Penrose's own contribution.

* * *

The Diabolic Root. *A Study of Peyotism, the New Indian Religion, Among the Delawares.*

By Vincenzo Petrullo. University of Pennsylvania Press, Philadelphia. \$2.00. $8\frac{1}{2}$ x $5\frac{1}{2}$; xi + 185; 1934.

Peyote, also known as mescal, *Lophophora Williamsii*, *Ehinocactus Williamsii*, and *Anhalonium Lewinii*, is a species of cactus which produces a kind of intoxication sometimes accompanied by visions and color hallucinations. The healing and religious cult developed around its use has spread from the Indians of northern Mexico to a number of tribes in the

United States. This book is a study of the cult as it has developed among the Delawares of Oklahoma. The meetings are held in a tipi with a fire in the center which has been kindled with flint and steel and a crescent shaped altar on which is placed a piece of peyote. The devotees eat peyote to the accompaniment of ritual songs. "Merely eating peyote is not enough. He must inspect his motives, attain the proper state of humility, and sincerely desire to lead a pure life." Among the Delawares of Dewey, who have so far as possible kept up their traditional religious ceremonies, the Peyote cult has been kept in substantially the form in which it was borrowed from other tribes, whereas among the Delawares of Anadarko, who no longer practise the traditional ceremonies, elements of these, as well as certain Christian elements, have been incorporated in the Peyote ritual. The book contains a bibliography of three pages.

◆

THE PROBLEM OF MENTAL DISORDER. *A Study Undertaken by the Committee on Psychiatric Investigations, National Research Council.*

Members of the Committee: Madison Bentley, Chairman; E. V. Cowdry. McGraw-Hill Book Co., New York. $4.00. 9 x $5\frac{3}{4}$; x + 388; 1934.

This is an important contribution to the literature on psychiatry. The first part consists of articles by the more noted individual exponents of the several schools of psychotherapy. Thus, C. Macfie Campbell presents the viewpoint of "clinical" psychiatry; A. Meyerson, that of "medical" psychiatry; I. L. Wechsler, that of the neurologist; A. Meyer speaks as a psychobiologist; L. S. Kubie as a psychoanalyst. The different concepts are ably summarized by the editors who note that the "commonest" feature is the influence of medicine, and "the strongest tradition in the facts and theories under scrutiny is that of the physicians treating a disease by accepted means of diagnosis and therapy." The second part consists of papers by specialists in the various disciplines that bear more or less directly on the problem of mental disorder, from anatomy to education. Some of these papers are better than others but all are worth reading.

◆

TWENTY-FIVE YEARS AFTER. *Sidelights on the Mental Hygiene Movement and Its Founder.*

Edited by Wilbur L. Cross. Doubleday, Doran and Co., Garden City, N. Y. 8 x $5\frac{3}{8}$; xv + 564; 1934.

DE OMNIBUS REBUS ET QUIBUSDEM ALIIS

THE SEARCH FOR TRUTH.

By Eric T. Bell. The Williams & Wilkins Co., Baltimore. $3.00. $8\frac{1}{2}$ x $5\frac{1}{2}$; x + 279; 1934.

Dr. Bell is a worthy successor of Augustus De Morgan. There are few writers who can make so readable a book out of such technical subjects as logic and scientific method. This is a highly unconventional history of man's efforts to solve the riddles of the world he lives in by means of deductive reasoning. The story begins with the discovery by the Egyptians of the formula for the volume of a pyramid. The next step is the recognition by the Greek geometers of the need for the abstract, deductive proof of their theorems by means of the rules of logic from certain postulates. "Thus it came about that the age of modern science, initiated by Galileo in the Sixteenth Century, inherited at least two Absolutes," the axioms of geometry and the laws of logic. However, in 1826 Lobatchewsky showed that a self-consistent geometry might be built up by altering one of the postulates of geometry and in 1930 Lucasiewicz and Tarski similarly proved that more than one self-consistent system of logic, in which a proposition may be neither true nor false, could be built up. And so our hopes of ever discovering the Truth go glimmering.

By way of interlude Dr. Bell pays his respects to Dean Inge, Jeans, Eddington, Dunne of the *Experiment with Time*, Maeterlinck and other mystical expounders of the fourth dimension, and all testimonial writers, whether for halitosis "cures" or for the reconciliation of science and religion.

* * *

BURGUNDY.

By Stephen Gwynn. Constable and Co., London. 5 shillings net. $7\frac{3}{8}$ x $4\frac{7}{8}$; 144; 1934.

This seems to us one of the best volumes that has so far appeared in *Constable's Wine Library*. This is high praise, because its predecessors have set a high standard. But burgundy is perhaps the most difficult group of wines to be thoroughly and soundly wise about. The French have so ordered matters by law that, within the confines of France itself, it is possible without serious risk of insult to palate or stomach to place that naive and abiding trust in labels so characteristic of Americans, as long as the discourse is of *clarets*. But the case is far otherwise as regards *burgundies*. There your taste is your only safe guide. One of the most famous, reliable, and completely honest of burgundy shippers in Nuits-St.-Georges told us once that a large percentage of his total product was shipped entirely unlabelled to the most luxurious hotels, restaurants and clubs of Europe, the buyer having the privilege of adorning the bottles with any device that might seem fitting to him and the circumstances, though he had been honestly and completely informed as to the wine's lineage and age. So it will be seen that to set up as a philosophic guide to the ignorant about burgundy demands a thorough and profound educational training and plenty of first-hand research. Mr. Gwynn qualifies nicely in this respect. He has produced a book that entertains as it instructs. We recommend it. Unfortunately it lacks an index.

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THE HUMAN GYROSCOPE. *A Consideration of the Gyroscopic Rotation of Earth as Mechanism of the Evolution of Terrestrial Living Forms. Explaining the Phenomenon of Sex: Its Origin and Development and Its Significance in the Evolutionary Process.*

By Arabella Kenealy. John Bale, Sons and Danielsson, London. 12s. 6d. net. $8\frac{3}{8}$ x $6\frac{5}{8}$; iv + 313 + 16 plates; 1934.

> In presenting the consideration that, as plastic clay on the rotating disc of little potter's wheel of industry is shapen and moulded in varieties of symmetrical three-dimensional form, increasingly uprising in the vertical, so upon the rotating surface of the great terrestrial potter's wheel of Creative Evolution, the plastic matter of terrestrial organisms has been shapen and moulded in the countless diversities of increasingly complex, structurally differentiated three-dimensional forms of living species, progressively uprising in the vertical in the terms of increasingly complex elevated posture—I have ventured to base my argument upon the Gravitation of great Newton, instead of on the later Einstein theory.

This hefty sentence opens a strange book. Miss Kenealy (who is, by the way, a Dublin L.R.C.P.) is a paradoxer in De Morgan's sense, and her book is a perfect example of how the paradoxer's mind works. One of its chief characteristics is a total inability to differentiate symbolism and analogy from reality. Another is a dreadful prolixity. But withal we are disposed to feel with De Morgan that the world would be a duller place without its paradoxers.

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THE CONCISE OXFORD FRENCH DICTIONARY.

Compiled by Abel Chevalley and Marguerite Chevalley. Oxford University Press, New York. \$3.00. $7\frac{1}{4}$ x 5; xx + 895 + 5 plates; 1934.

This excellent French-English dictionary has the useful feature of danger signs warning the user of differences in meaning of French and English words of like form, such as *dérider* and "deride." Besides the inclusion of technical terms pertaining to automobiles, airplanes, etc., diagrams of an airplane, an automobile, a motor, steam and sailing ships, photographic apparatus, and architectural forms with the French and English names of the various parts are given.

* * *

THE ADVANCE OF SCIENCE.

Edited by Watson Davis. Doubleday, Doran and Co., Garden City, N. Y. \$3.50. 9 x $5\frac{7}{8}$; xiv + 400; 1934.

The editor of this book, who is also editor of Science Service, has summarized briefly and for popular consumption scientific discoveries and inventions of the last few years. In some cases he has added the historical background relative to the particular problem. The subjects included cover the whole gamut of science from cosmic rays to Neanderthal man. It is surprisingly free from errors and within its limits really excellent. Complete references would give it greater utility.

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Atomic Structure and Spectral Lines.
By Arnold Sommerfeld. Translated from the Fifth German Edition by Henry L. Brose. E. P. Dutton and Co., New York.
$10.80. $8\frac{1}{2}$ x $5\frac{1}{2}$; xi + 675; 1934.

This English translation of the latest edition of Professor Sommerfeld's classic text on atomic structure is of undeniable value as text for advanced physics courses in English speaking universities. The work has undergone a complete revision in order to include the most recent work in spectral analysis. The Rutherford-Bohr atom is still held as a useful model for interpreting the main features of spectroscopic phenomena.

◆

Report on Conference on Supervised Correspondence Study. *To formulate policies regarding its use as a practical means of enriching the curriculum of American Secondary Schools.*
International Textbook Co., Scranton, Pa.
25 cents. 9 x 6; 66; 1934 (paper).

A brief report of the findings of a Conference held among various state educators at Teachers College, Columbia, August 1934. The whole subject is still in such a pioneer state that no important conclusions came out of the conference.